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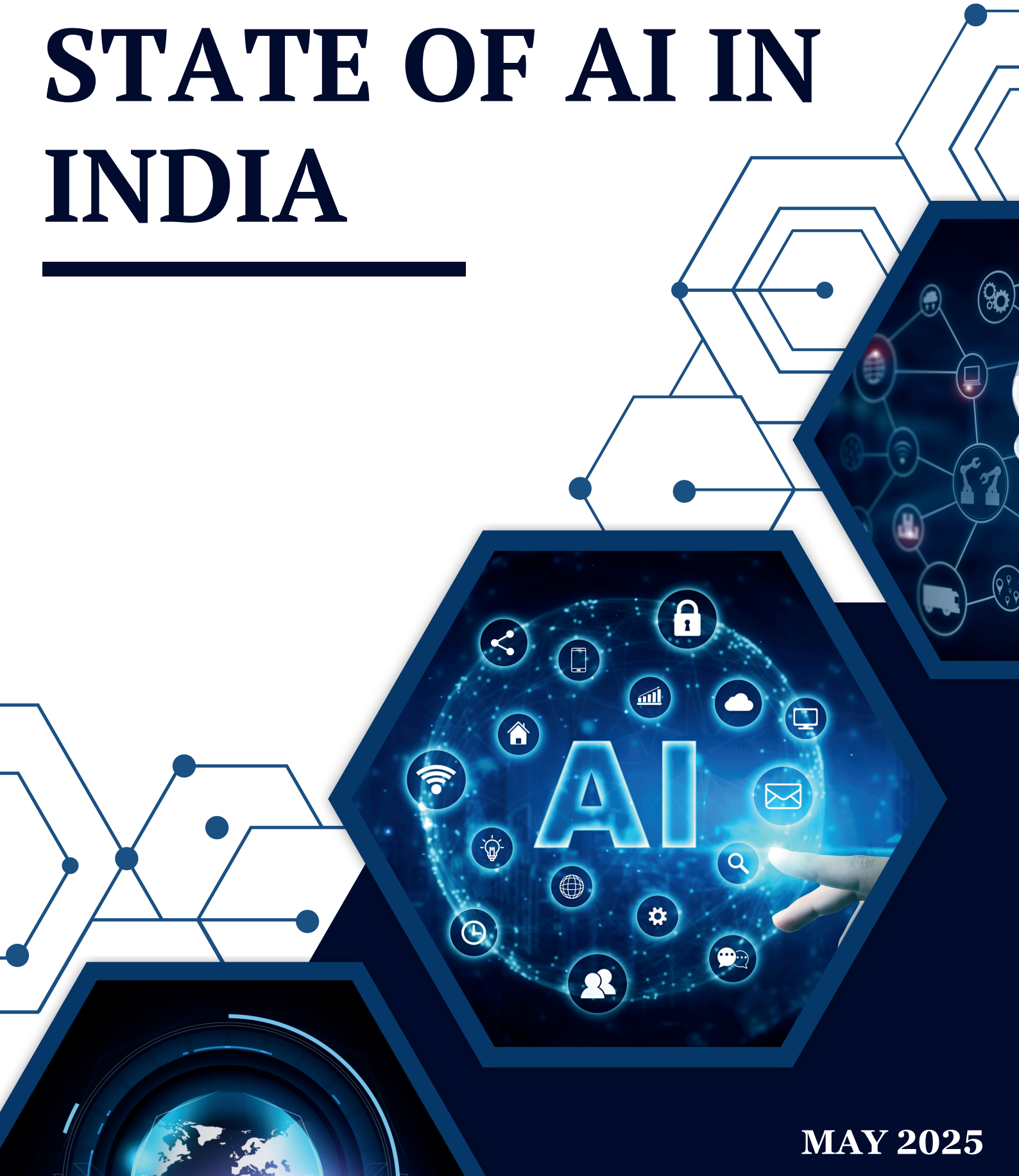
# STATE OF AI IN INDIA

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CPRG

# REPORT

# STATE OF ARTIFICIAL INTELLIGENCE IN INDIA

Published by,
Dr. Ramanand,
Center of Policy Research and Governance,
102, Silver Arch Apartments, 22, Firoz Shah Road,
New Delhi- 110001
office@cprgindia.org

# ABOUT CPRG

*Transforming ideas into impactful policies*

The Center of Policy Research and Governance (CPRG) is an independent public policy think tank that aims to promote responsive and participatory policy-making. As one of 17 Indian Council of Social Science Research (ICSSR)-recognized institutions, it conducts cutting-edge research and analysis across diverse policy areas. CPRG works in close cooperation with leading public policy practitioners and scholars to provide effective solutions for contemporary policy challenges. Additionally, it actively provides training and opportunities for young individuals interested in pursuing a career in policy-making and governance.

Through its ‘Future of Society’ initiative launched in 2024, CPRG has established itself as a leading voice in AI governance. This initiative examines the societal impact of emerging technologies, anticipates rapid shifts, and develops forward-looking policy agendas across education, the economy, and urban development. CPRG’s influence extends through its Policy Conclave series, which engages senior government officials and industry leaders, and the "Transforming Society through AI Fellowship," which empowers emerging social scientists. Recognized globally, CPRG was among the few research institutions invited to the GPAI Summit 2024 in Serbia. These initiatives, alongside regular policy dialogues and specialized webinars, showcase CPRG’s holistic approach to ensuring ethical, inclusive, and human-centric AI development.

# INTRODUCTION

Artificial intelligence is reshaping sectors worldwide, transforming processes, personalizing user experiences, and driving strategic decision-making. With rapid advancements in computing power and machine learning algorithms, AI has transitioned from an auxiliary tool to a core enabler of economic transformation. As AI systems become more sophisticated, their integration into diverse industries - ranging from law and urban planning to tourism and hospitality - is creating both new opportunities and challenges. Therefore, the future will require a balanced approach - leveraging AI's capabilities while ensuring that human judgment, ethical considerations, and inclusivity remain central.

India, home to a rapidly growing digital economy, stands at the forefront of this AI-driven revolution. The country has witnessed a significant push toward AI adoption, with both the public and private sectors leveraging artificial intelligent systems to enhance service delivery, optimize operations, and improve user experiences. Government initiatives such as the National AI Strategy and AI-driven public infrastructure projects reflect India's commitment to harnessing technology for economic growth. At the same time, businesses are increasingly deploying AI for automation, data-driven decision-making, and customer engagement. This convergence of policy, investment, and technological progress presents a unique moment for India to shape its AI ecosystem in a way that is both inclusive and globally competitive.

Within this broader context, this report offers an in-depth analysis of AI adoption across key sectors in India, namely urban planning and construction, tourism and hospitality, and law. Each chapter explores AI's role in industry transformation, readiness for integration, and associated challenges. Taking an ecosystem-based approach, the study views AI adoption as a fundamental shift, not just a technological upgrade. For instance, in urban planning and construction, AI-driven models are enabling cities to optimize land use, enhance infrastructure planning, and improve disaster management strategies. Similarly, in the legal sector, AI is streamlining case research, contract management, and judicial processes, offering significant efficiency gains while also raising important ethical and regulatory considerations. In tourism and hospitality, AI is playing a pivotal role in redefining customer interactions, optimizing pricing strategies, and enhancing operational efficiency through predictive analytics and automation. Beyond sectors, this report explores AI's impact on progress, ethics, and human oversight. While AI offers immense potential to enhance productivity, concerns surrounding privacy, algorithmic bias, regulatory gaps, and the displacement of traditional roles must be addressed to ensure a responsible and equitable AI ecosystem.

A particularly insightful aspect of this report is its incorporation of firsthand interviews with practitioners and industry experts, adding a ground-level perspective to AI adoption in India. These insights, combined with extensive desk research, ensure that the findings remain both data-driven and reflective of real-world applications. Each chapter concludes with a forward-looking perspective, outlining recommendations for all stakeholders to navigate the evolving AI landscape.

The chapters of the publication have been authored by our contributors, namely, Ms. Archita Ray, Ms. Amisha Budhraja, Ms. Kirti Advani, and Ms. Shaivie Sharma. We also extend our gratitude to Mr. Tarun Agarwal for his assistance in coordinating with the contributors and refining this work.

At its core, this report underscores a central theme: AI adoption in India is not merely a technological shift but a societal transformation. The coming decade presents a critical window of opportunity to align AI advancements with the nation's broader developmental goals. With strategic investment, regulatory foresight, and a commitment to ethical AI practices, India is well-positioned to leverage AI as a force for inclusive growth, propelling the country toward the vision of 'Viksit Bharat 2047.

**Editors**
**Dr. Ramanand & Mr. Pranav Gupta**

# HUMAN RESOURCE MANAGEMENT

## INTRODUCTION

Artificial Intelligence is no longer a distant dream but is now an integral part of the modern workplace. As technologies continue to transform industries, human resources management is also evolving. Due to the increased interaction of AI with Human Resource Management, the global market for generative AI in HR is projected to reach $2091 million by 2032, growing at a staggering CAGR of 15.77%.[1] The deployment of machine learning tools and natural language processing by the HR departments has automated repetitive human tasks and resulted in efficient decision-making. According to a report highlighting the growing role of AI in HR, 'The New Age of Work - Trends, Technology and Talent', from HR tech platform Keka, 41% of recruitment jobs may be automated globally by 2030.[2] Various organizations have increasingly used predictive and data-based approaches for talent acquisition and employee engagement to enhance job seekers' experiences, allowing HR professionals to focus on more strategic tasks. Around 40% of organizations will have to reskill their workforce due to the implementation of AI and automation over the next three years in a wide range of areas like record management, recruitment scheduling, payroll processing, and performance databases.[3]

These enhancements have highlighted a shift in focus from routine tasks to strategic initiatives, with workforce upskilling becoming a critical priority, as shown in a study conducted by SHRM India, HR Priorities, and AI in the Workplace. The report revealed that 31% of companies in the country currently implement AI in human resources functions. Around 57% of HR leaders believed that AI in HR would reduce workload but required the development of their workforce to equip them with AI skills.[4]

Furthermore, according to Accenture's strategic report, for coordination and employee management, AI-powered systems can help HR managers speed up their daily tedious and repetitive work by providing powerful database and analytical support.[5] The report also stated that the success of any organization depends on how effectively it intelligently combines people, processes, and technology to deliver transformational value at an optimized cost.

This paper seeks to analyze the role of AI in human resource management, focusing on the transformation of processes due to AI integration in recruitment, data management, talent acquisition, learning & development, and administration benefits while identifying opportunities and challenges. Subsequently, it emphasizes the intersection of human intelligence and technological proficiency for HR operations for organizations to stay competitive.

The first section of the report assesses the impact of AI on recruitment and candidate sourcing, automating routine tasks and mitigating labor shortages.

## AI IN RECRUITMENT AND CANDIDATE SOURCING

Indian companies are increasingly relying on artificial intelligence for recruitment efficiency and boosting the performance of employees. According to the IBM Global AI Adoption Index 2023, 59% of large Indian organizations have adopted AI, with another 27% exploring its use.[6] AI is helping to streamline HR processes, cut recruitment costs, and enhance efficiency. While examining the role of AI in recruitment and addressing labor shortages, a senior employee at IBM stated that Chat-GPT's arrival has accelerated the adoption of AI in HR and that robots might replace many HR roles over the next five years.

There have been cases where generative AI and tools such as Mya automate the recruitment process, from sourcing to interviewing, and help identify skill gaps, thereby assisting in choosing the best applicant. One of the HR managers in a Human Capital Management company stated that automation has led to quick interview scheduling. They use AI algorithms to match candidates with suitable roles based on skills, experience, and preferences. They use cloud-based infrastructure to analyze large datasets, provide personalized results tailored to the needs of the organizations, and look for trends.

The IT and ITES firms, one of the largest employers in the services sector, are using in-house AI tools and chatbots for recruitment and personalized query handling. Infosys uses AI tools to support employees and automate routine tasks. According to the head of human resource development, natural language processing capabilities provide instant responses to common questions, and AI fosters innovation, optimizes operations, and screens candidate profiles. It also uses facial recognition to reduce impersonation risks and voice-recognition systems at help desks so that employees can directly connect with the concerned people. This incorporation of AI has delivered strong financial performance with approximately 20% annual growth, and data analytics to evaluate employee performance more objectively.[7]

Similarly, HR professionals in startups such as Shortlist and Hirect said they offer chat-based platforms connecting job seekers and recruiters, reducing manual screening efforts. The AI-based tools used by these HR departments help update the hiring status and resolve queries related to employment grievances. It helps them to focus more on complex activities and implement new strategies to enhance the employee experience and help meet the organization's goals. For instance, they use AI-driven tools like Peoplebox (data and talent analytics) and Lattice (performance reviews) to structure the profiles using the information from employee profiles and identify any skills gaps in their organization to develop upskilling programs based on market trends. This surge in AI-powered recruitment solutions is projected to grow as companies look to streamline hiring processes and improve job match quality.

In an interview with a senior HR department employee of a Delhi-based company, he shared that the usage of AI has reduced the interviewer's time by converting a 15-minute video interview into a set of 20,000 data points for facial movements, intonation, and word selection thereby automatically sorting the profiles into different categories for easier selection.

The growing adoption of AI has reduced investment in HR workforces, with roles previously handled by ten employees now being managed by only two. According to the HR manager of a medium-sized company in Delhi, smaller organizations with less than 500 employees are more likely to integrate AI into their HR functions. To compete with larger organizations and establish themselves in the market, these companies prioritize technology, responsible AI, and innovation over investing in recruitment and upskilling HR teams. These innovations have improved employee retention and enhanced data management of personal information, reducing reliance on manual screening processes, which are discussed in the following section.

## AI IN ONBOARDING AND DATA MANAGEMENT OF EMPLOYEES

Artificial intelligence in human resources can further personalize work shifts and administrative tasks, giving employees company-specific and tailored guidance. By automating onboarding steps for setting up accounts, delivering training, and integrating employees into organizational systems, platforms like PeopleStrong employ an AI-powered Human Resource Management System (HRMS) to centralize employee records and securely manage sensitive data.[8] According to a report by the Bureau of Labor Statistics, the number of hires in 2022 rose to 77.2 million, up from 76.1 million in 2021, underscoring the growing need for streamlined and efficient onboarding processes to manage the growth.[9]

One of the notable examples is Wipro, where AI-supported tools have led to cognitive automation, predictive analytics, and advancement in career opportunities. Wipro's GenAI chat, WiNow, assists employees in the onboarding processes and has drastically reduced the time for verification of candidates from 11 days to 48 hours. The company plans to invest $1 billion over the next three years to train its workforce in AI. It also aims to bring together 30,000 employees from data analytics and consulting to integrate AI into its operations and client solutions.[10]

The elimination of manual screening processes and the integration of AI into existing HR systems has made the training period of employees more structured and self-driven. The Marketing and HR Director of a renowned company stated that AI tools like GPTs have been increasingly generating content and sending automated feedback to employees, thereby improving efficiency and time management. Moreover, the IDC report (2023) predicted that 80% of the global 2000 companies are expected to use algorithmic managers to hire, fire, and train employees by 2024, demonstrating a clear trend toward data-driven employee management.[11]

A notable example is Edge Networks, a Bengaluru-based startup leveraging machine learning to match candidates with job roles, streamlining the hiring process and improving talent retention. The senior employee of the company said that generative AI has saved approximately 70% of expenses by minimizing reliance on external agencies.

The management of employees' personal information has also been driven by AI-powered analytics, giving insights into their past roles and skills, aiding in strategic planning and talent management. Applicant Tracking System (ATS) enables recruiters to keep track of all applications without making the process more laborious and personalizes each stage of onboarding. While highlighting the benefits of this automated dashboard, the HR manager of an IT company stated that though this helps in quicker selection and personalized modules, it also results in a lack of transparency and privacy issues. She said that only 15% of the HR workforce is aware of how to use AI tools, while around 85% require reskilling programs. Further, a McKinsey report indicated that only 9% of HR departments use AI in data and talent management, reporting 40% reduced costs and 60% increased revenues.[12] The following section explores how this integration of AI into HR functions has boosted employee performance and productivity rates.

## AI IN PERFORMANCE MANAGEMENT AND EMPLOYEE ENGAGEMENT

Performance assessments can be difficult and time-consuming because of their subjective character. With the emergence of AI in HR management, around 25% of organizations have reported that they rely on generative AI for performance records, assignment metrics, and peer comments to provide more objective and insightful performance reviews.[13] Smart recruiting analytics that identify performance gaps have been used by HR management firms to develop unique strategies that support employees in succeeding. More importantly, generative AI may provide targeted, helpful comments based on each employee's positives and negatives.

Accordingly, HCL Technologies has also integrated AI-powered tools to foster skill-based talent management, shifting from static job roles to more fluid career development approaches. It uses AI-driven HR analytics to empower organizations with actionable insights, automation, and enhanced customer experiences.[14] Furthermore, AI-driven functions can facilitate the identification of high-potential employees, talent development opportunities, and succession planning strategies, ensuring a steady pipeline of skilled and engaged employees to drive organizational success. Further, to enhance employee engagement, systems like Enboarder are utilized by HR departments to track productivity, attendance, and overall performance with data-driven insights. While these AI-powered predictive modeling techniques help in gauging employee performance, the HR manager of a manufacturing company stated that domain knowledge is essential for understanding the performance of employees in a particular department. Additionally, Darwinbox, a Hyderabad-based HR tech startup employs machine learning to analyze employee performance metrics, enabling companies to

make data-driven promotion and retention decisions. The cloud-native platform automates and optimizes the performance of the entire HR team for over 950 enterprises globally, empowering employees to focus on strategic initiatives and flexibility in working.[15] Approximately 54 percent of Indian companies, according to the PwC India Survey, employ predictive AI for workforce planning, enhancing the accuracy of resource allocation and reducing operational risks associated with staffing gaps.[16]

Similarly, Tata Consultancy Services (TCS) uses AI-powered analytics and predictive models to improve talent acquisition processes by reducing mismatches by nearly 25%. It also employs AI algorithms to evaluate employee performance, leading to a boost in employee productivity and training completion rates. It has trained approximately 8,000 employees in generative AI in just one quarter of 2023.[17] Meanwhile, TCS has collaborated with Microsoft and Google to upskill its employees, with plans to train 25,000 staff on Microsoft's Azure OpenAI technologies and 50,000 on foundational AI concepts to enable TCS to meet client demand for AI-driven solutions.[18]

The integration of AI-driven processes in employee engagement has further improved payroll management and workforce efficiency. This shift not only streamlines HR functions but also leads to regulated benefits administration and growth opportunities, as discussed in the subsequent section.

## AI IN PAYROLL AND BENEFITS ADMINISTRATION

AI-driven solutions are transforming payroll and benefits administration by streamlining processes, reducing errors, and enhancing the overall employee experience. These technologies provide a data-driven approach to managing compensation and benefits, ensuring efficiency and compliance with regulatory requirements. The emergence of AI in HRM has focused on payroll management to automate calculations, ensure accuracy, and maintain compliance with labor regulations. According to Eightfold AI's survey, 77% of HR departments in India use AI in payroll processing and benefits administration.[19] This has led to making payroll processing more streamlined and reducing administrative workload, offering organizations a seamless way to manage compensation, benefits, and deductions without manual intervention.

AI-driven HR systems utilize advanced algorithms to provide alerts about policy changes and deadlines, thereby minimizing the risk of non-compliance and associated penalties. These systems also detect anomalies in payroll transactions, such as duplicate payments or unauthorized alterations to employee records, ensuring the protection of sensitive data and the maintenance of financial integrity.

The integration of AI has also helped in salary administration. As the employees' bank accounts are linked, the salary will automatically be credited to their accounts, and all the tax-related issues will also be resolved.

Companies implementing AI-driven administrative management systems have observed an increase in employee performance, driven by continuous feedback that replaces traditional annual reviews with real-time monitoring and goal setting. According to Zoho's AI and HR Predictions for 2025, AI integration has enabled HR managers to use machine learning platforms for preparing reports related to EEO, tax compliance, employee hours, and DEI by efficiently collecting, structuring, and analyzing relevant data, thereby facilitating quicker processing of various documents.[20]

The organization of calendars and meetings through Virtual Assistant Systems and coordination with employees through GenAI has resulted in it becoming the so-called "advisor system," raising the bar of accuracy and proficiency. While AI is still in early adoption, a 2024 Deloitte Generative AI survey suggested that 70% of organizations have been using high GenAI expertise to improve existing services and enhance recruitment processes, and 45% said they plan to reinvest savings from GenAI initiatives into more innovation opportunities. It has led to cost-efficient and time-saving automated ways of managing human resources.[21]

AI has also enabled HR teams to access real-time insights into compensation trends, overtime patterns, and benefits utilization. These analytics support data-driven decision-making, helping organizations maintain competitive pay structures and align with employee needs and market standards. Furthermore, the increasing integration of AI into HR systems has highlighted the crucial role of the learning and development department in equipping employees with AI skills and enhancing operational efficiency, as discussed in the following section.

## AI IN LEARNING AND DEVELOPMENT (L&D)

The integration of AI into learning and development (L&D) within human resources (HR) has revolutionized traditional processes, enhancing efficiency, accuracy, and personalization. The SHRM study stated that HR managers will plan a digital or online training program for employees which will help them eliminate the skill gap and track their progress. Various AI-driven tools and technologies, such as Optical Character Recognition (OCR) and natural language processing (NLP), are transforming HR practices. Around 50% of organizations use AI for personalized opportunities and approximately 20% use it for upskilling the workforce.[22]

According to Deloitte's 2017 Annual Global Human Capital Trends report, 53% of companies are ready to deploy digital tools, while 22% have already implemented them.[23] These tools drastically reduce recruitment timelines and improve hiring precision by identifying candidates best suited for specific roles. Similarly, the manager in the HR department of a Delhi-based company said that platforms like HireVue enable managers to conduct interviews using pre-recorded questions, with algorithms analyzing responses to select candidates based on organizational requirements.

These innovations not only optimize the recruitment process but also help in developing employees for specific roles.

AI plays a critical role in employee training by automating data collection and analysis. By analyzing this information, managers can quickly assess the effectiveness of training programs and identify areas for improvement. This eliminates the need for manual oversight, saving time and allowing HR professionals to focus on strategic tasks. AI-driven platforms can also create customized learning curricula for employees. For instance, Springworks, an Indian HR technology startup, uses AI and NLP technology to create customized learning paths and employee skill development programs, aligning training modules with individual roles and capabilities.[24] AI can also help conduct skills audits by analyzing employee profiles against market trends, identifying skill gaps, and suggesting targeted upskilling initiatives. Additionally, intuitive AI tools can track learning progress, providing real-time feedback and insights to both employees and managers.

Furthermore, AI fosters a culture of continuous learning and adaptability within organizations. By leveraging predictive analytics, HR departments can anticipate skill gaps and proactively design training modules to address them. It reduces biases in hiring and training by relying on data-driven decision-making, promoting diversity and inclusivity in the workplace. AI-driven learning platforms like EdCast are transforming skill development and training within HR departments to tailor learning experiences and close skill gaps in emerging fields like data science and AI.[25]

## CHALLENGES

The adoption of AI in the Human Resource Management Industry presents significant challenges apart from the benefits offered. The complexity of ethical and responsible AI has been hindering the full-scale deployment of AI in HRM systems. The major issue lies in integrating AI with the existing HR systems, highlighted by the IBM study, is the lack of tools/platforms for developing AI models (28%) and the lack of company guidelines (55%). The concerns regarding cybersecurity and data breach risks heighten, as sensitive employee information becomes vulnerable to unauthorized access during the transition from traditional systems to AI-powered ones. Skill gaps in HR teams present another hurdle, alongside biased algorithms that may perpetuate discrimination. Challenges also include dilemmas around transparency and accountability in HR decisions, particularly in automated layoffs, promotions, or dismissals, which can lead to legal issues. The lack of human touch in AI-driven processes can strain employee-employer relationships, while fears of job displacement and rising unemployment persist. Privacy issues arise as AI systems often function as 'black boxes', leading to irrational decisions without human oversight, further complicating the balance between automation and human intervention.

## FUTURE OUTLOOK

The future of artificial intelligence (AI) in human resource management (HRM) will lead to an era of efficiency, personalization, and strategic impact. While prioritizing ethical guidelines, HR departments will redefine their work, implement access controls, and ensure transparency in AI-driven analytics. These measures will address fairness, bias mitigation, risk management, and regulatory compliance. This integration might result in literacy programs within HR teams to train employees for data-driven decision-making.

As routine HR tasks are automated, roles will shift towards strategic thinking and multi-skilled capabilities, generating demand for jobs that blend business acumen with AI expertise. AI-powered tools will revolutionize HR practices, from recruitment to performance management, offering personalized experiences for employees and deeper insights into workforce dynamics. This will also enforce empirical methods to assess the impact of AI-driven analytics on HR outcomes.

While AI holds immense potential, empathy and emotional intelligence—core to HR—remain beyond its reach, necessitating a balanced approach. The HR professionals will always need to train the algorithms to ensure accuracy and ethical decisions. Organizations will have to align AI adoption with their values, culture, and employee needs, taking a cautious and thoughtful approach to mitigate risks. For organizations in India, particularly, embracing AI will be key to remaining competitive and encouraging innovation in an increasingly dynamic global labor market.

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# LAW AND LEGAL RESEARCH

## INTRODUCTION

Artificial Intelligence (AI) is redefining industries globally, with the legal sector standing out as a field primed for transformation. The legal profession, inherently grounded in the interpretation of past cases and established laws to solve new challenges, naturally aligns with the data-driven, analytical capabilities of AI and machine learning. In recent years, AI has proven valuable in streamlining complex legal tasks, from research and case management to client interactions, making the sector more efficient, accessible, and responsive. This journey toward a digitized legal system began with the 'e-Court Project' in 2007, under the National e-Governance Plan, marking the beginning of deeper technological integration in the judiciary.

However, it was the COVID-19 pandemic that significantly accelerated the adoption of AI among various stakeholders in the legal sector. With the judicial process being an 'essential service', the pandemic necessitated the rapid development of virtual tools for e-filing, online payment of court fees, case tracking, and even virtual hearings. As rightly pointed out by Justice Sikri, "The wheels of justice cannot be halted due to lockdown" a sentiment that echoed the need for innovation[1] The Delhi High Court took significant steps during the Pandemic such as establishing e-rooms, making certain courtrooms entirely paperless, and allowing individuals to check their case details via online portals. These transformative initiatives were a step forward to ensure uninterrupted access to justice in challenging times. Realizing the need for a more technologically equipped judicial system, the Government of India subsequently made integration of artificial intelligence mandatory in the court functioning to help clear case backlogs and reduce delays. Yet, the rate and extent of AI adoption among legal practitioners in India remains limited with immense scope for increase.

This report examines the role of AI in reshaping legal practice across critical areas, such as legal research, case management, and client relations, identifying both the opportunities and obstacles that AI presents in India. By analyzing these applications, this report aims to provide nuances of AI's current and potential impact on India's legal sector, while also outlining the challenges that must be addressed to maximize its benefits and limit its abuse.

## APPLICATIONS OF AI IN LEGAL PRACTICE

Artificial Intelligence continues to transform legal practices by empowering legal professionals with tools that enhance productivity, speed, and accuracy while expanding levels of client service. As the legal practice transitions from traditional, paper-intensive to digital methods, AI-driven tools are increasingly becoming integral and emerging as essential assets in key areas such as legal research, case management, and client interaction.

AI now enables the automation of document analysis, and predictive analytics, and facilitates real-time client communication. Such wide-ranging applications are reshaping the daily work of lawyers, paralegals, and case managers alike. This section explores how AI is shaping legal practice, bringing both efficiencies and challenges that practitioners must navigate in this evolving digital frontier.

## AI IN LEGAL RESEARCH

Legal research presents unique challenges for professionals, as they must navigate extensive collections of case law, statutes, regulations, and commentaries. This process is often time-consuming and prone to error, with a risk of overlooking critical information amidst vast data volumes. AI has transformed the tasks associated with legal research, enabling automated document review, sorting, and analysis to enhance efficiency.

A LexisNexis survey[2] found that lawyers in India see significant potential in generative AI tools, with nearly two-thirds (65%) of the respondents citing benefits in research assistance, more than half (56%) in document drafting, and almost 44% in document analysis.[3] Cyril Amarchand Mangaldas, a major Indian law firm, became the first in the country to license 'KIRA,' a machine learning program from Canada's Kira Systems. KIRA enhances document review by identifying risks and extracting key provisions. KIRA leverages advanced Natural Language Processing techniques and ML algorithms. These methods allow KIRA to parse, classify, and understand complex legal language, making it highly effective for legal document analysis and review.

In the field of legal research, natural language models (NLP) and AI+ML (Machine learning) platforms have revolutionized the process of due diligence. In an interview a counsel at a prominent corporate law firm, reflected on how AI has transformed legal research, eliminating the need for shelves of law books. Instead of sifting through extensive texts and case laws, professionals now rely on digital legal databases such as Manupatra, Kanoon AI, and SCC Online. An arbitration specialist noted that while these tools have been in use for over a decade, many didn't realize they were AI-driven. However, both advocates agreed that these tools are predominantly "input-dependent," making them most effective for initial research stages. The quality of results hinges significantly on the precision of keywords entered. Lawyers across the board concur that upskilling is essential to fully harness the advantages AI offers in the legal field.

Legal research platforms such as CARA AI utilize advanced data management tools for advanced research of extensive legal databases.[4] Platforms like CaseText, with context-aware AI search engines like CATA, streamline precedent identification, enabling professionals to identify relevant precedents and helping in strengthening their legal arguments thus in strategic case-building.

A Supreme Court advocate shared that in high-stakes transactions like mergers and acquisitions, AI significantly enhances due diligence processes by evaluating legal standards and identifying potential risks.[5] Additionally, AI-enabled chatbots using advanced large language models are increasingly being used to assist lawyers, judges, and the general public. These tools facilitate a better understanding of legal terminology and improve access to legal information.

According to a legal practitioner, given the sensitive nature of client needs and the vast scope of legal research, AI tools are often used as supplementary resources rather than primary sources as their reliability is not widely trusted. Human reasoning remains essential to legal research. While some lawyers use AI for drafting counter-affidavit arguments, an arbitration attorney noted that these tools are sometimes inconsistent in their results. She further mentioned that crafting specific denials remains a tedious task that machine learning has yet to master. Additionally, not every case cited by AI is appropriate for forming the basis of a lawsuit. In legal research, AI is primarily used as a "litmus test" for verifying and cross-checking legal proceedings rather than as a primary source of information.

While various legal practitioners agree that AI use in legal research is still limited, its application in drafting is significant. LLM-based tools like LegalRobot are being increasingly used for automating drafting tasks. Moreover, platforms such as ChatGPT, Perplexity, and other law-specific generative AIs like "AI Lawyer" assist with repetitive tasks like document drafting. These tools also review and compare documents to ensure accuracy and relevance. A Supreme Court advocate noted that AI-generated documents have an accuracy rate of about 85%, making it a cost-effective option for independent practitioners. Although premium versions of applications like ChatGPT Pro are expensive, they are still cheaper than hiring clerks for drafting. Another advocate mentioned that using AI cut her drafting time by half, making it highly efficient. Generative AI has also proven useful for transcription (image-to-text), translation (particularly Hindi to English and vice versa), spell checks, and grammar checks. Several downstream tasks, such as summarizing legal judgments, legal searches, and case law analysis—which were once performed manually—are now automated with AI-enabled technology. Advocates agreed that AI is highly efficient in drafting work, though human vetting remains essential for final approval. Another lawyer noted that bespoke drafting remains entirely dependent on human intelligence. Moreover, advocates expressed that legal work cannot be entirely machine-enabled due to numerous ethical considerations and liabilities. Nevertheless, there seems to be a growing perspective that adapting to AI will make the sector more efficient.

## AI IN CASE MANAGEMENT

The legal services industry in India is growing at an annual rate of approximately 40% and, in terms of size, is comparable to the US legal industry,[6] yet it remains partially

digitized. AI-driven case management systems are transforming this landscape, enabling efficient file organization, deadline tracking, and improved client-attorney communication. By incorporating AI, legal professionals can focus more on strategic analysis and complex problem-solving, ultimately enhancing the quality of legal research and practice.[78]

LLM-based tools and AI-based legal operations management software such as Latch (for contract review), Clio, and Smokeball are increasingly being used for case management. These platforms provide document automation, time tracking, billing, and client communication tools. Such automation tools help law firms save valuable time and resources by streamlining repetitive tasks and providing smart suggestions for document drafting and case management.

These notifications function like push notifications in other apps, making the tool extremely user-friendly. He also highlighted the use of common AI apps like Fathom AI, for efficient note-taking. Additionally, he noted that individual practitioners like himself use AI for client billing, especially when dealing with large corporate clients who require comprehensive billing. A lawyer mentioned that in the case of judicial documents, especially at the district and high court levels, shorthand remains the most prevalent form of documentation. Despite the inherent inefficiencies of shorthand, its use continues to this day.

AI's role in the legal industry is expanding from streamlining case management to enhancing client interactions. While tools improve efficiency in document handling and billing, AI is also improving client communication, enabling quicker responses, and offering real-time case updates. This shift supports a more client-focused approach, enhancing transparency and strengthening client-lawyer relationships, as explored in the next section.

## AI IN CLIENT MANAGEMENT

AI tools, such as chatbots and virtual legal assistants, can quickly respond to client inquiries, thereby improving communication and overall client satisfaction. One example is Lawyer Desk, a legal-tech startup that initially launched a platform for advocates and practicing lawyers, later expanding with 'Prajalok' a platform providing citizens with legal information, guidance, resources, and case tracking.[9]

A lawyer highlighted that AI-enabled tools like Mercury assist in real-time case tracking across courts, which is useful not only for legal practitioners but also for clients whose cases are being managed. AI facilitates the gathering of client information, assesses case relevance, and helps determine case suitability. Additionally, it enhances client satisfaction by streamlining workflow management processes, such as providing real-

time case tracking, which fosters transparency and trust between clients and their legal representatives. AI also assists in collecting client feedback, further strengthening client-lawyer relationships.

Another use of AI is in preparing invoices for lawyers based on completed work, especially in billing processes involving large corporations. A Supreme Court lawyer shared that a detailed bill can be generated in the required format (tabular, linear) for services provided by the lawyer. He noted that this not only saves time but also improves client relations by ensuring transparency in financial matters. Generative AI models and chatbots assist firms, clients, and lawyers in accurately calculating billing for services rendered, especially as legal services often prove costly by the end of a case. However, a counsel at a corporate firm mentioned that big law firms still primarily use Excel for generating bills rather than relying on AI.

There is a near-unanimous opinion among legal practitioners that, although AI usage in client management is currently limited, its application is likely to increase as AI becomes more integrated into corporate processes such as billing, taxation, and human resources. This increase is expected particularly in large law firms with the resources to adopt advanced AI solutions.

As AI tools enhance client management within law firms, they are also being integrated into the broader judicial system, aiming to improve court efficiency and public access to legal resources. While law firms benefit from AI in managing client interactions, billing, and workflow, Indian courts are beginning to adopt AI-driven innovations to address challenges like case backlog and information accessibility. The following section explores how AI is reshaping the judicial landscape, with initiatives such as the Supreme Court's SUPACE portal leading the way in supporting judges and streamlining case processing.

## AI INNOVATIONS ADOPTED BY THE INDIAN COURTS

As AI continues to enhance client management, it has also been embraced within the judicial system, with innovations tailored to meet the unique needs of courts and improve access to justice. In collaboration with the National Informatics Centre, the Supreme Court of India launched a multilingual mobile application that provides citizens with easy access to the display board, case listings, daily orders, judgments, important circulars, and other essential information. In addition to these advancements, Indian courts have started exploring AI tools like ChatGPT in legal proceedings, reflecting a cautious yet growing trend of AI integration in the judiciary.

In March 2023, Justice Anoop Chitkara of the Punjab & Haryana High Court utilized ChatGPT to gain jurisprudential insights on bail decisions in cases involving cruelty.[10]

The AI's input, though not case-specific, provided a broader legal context, assisting the judge in denying bail to the accused in an assault leading to death. Similarly, the Manipur High Court mentioned its reliance on ChatGPT 3.5 and Google for additional research while adjudicating a case, signaling a willingness to incorporate AI for supplementary legal research. In another instance, the Delhi High Court under Justice Pratibha M Singh, while ruling in favor of Christian Louboutin in a trademark dispute, witnessed the use of ChatGPT-generated responses by the plaintiff to demonstrate brand reputation. However, Justice Singh rejected AI-generated inputs for deciding factual or legal issues, citing concerns over potential inaccuracies and the imaginative nature of AI outputs.[11] These examples illustrate Indian courts' cautious adoption of AI tools, focusing on their utility for legal research while emphasizing the critical role of human judgment in decision-making.

**SUPACE (Supreme Court Portal for Assistance in Court's Efficiency)**

The National Judicial Data Grid (NJDG) documented that around 4,53,31,498 cases are pending at the District and Taluka levels and 61,03,561[12] are still unresolved at the High courts (20 October 2024).[13] In the Supreme Court, the pendency rate rose from 60,469 cases on March 1, 2020, to 66,727 cases on March 1, 2021, reaching a rate of 10.35%.[14] This backlog, along with the resulting delays, creates frustration and anxiety in the justice delivery process, demanding extensive time, resources, and reliable information. To address these delays, the then Chief Justice of India, Justice Sharad Arvind Bobde introduced the SUPACE portal in April 2021.

This is an AI-enabled tool to support judges by efficiently gathering relevant legal information, thereby streamlining research and case management. Using machine learning, it processes case data and provides it to judges. Currently, the portal is being tested on an experimental basis by judges in the Bombay and Delhi High Courts, specifically in criminal cases. Rather than making decisions, SUPACE focuses on processing information to provide judges with the necessary inputs for their rulings.[1516]

**SUVAS (Supreme Court Vidhik Anuvaad Software)**

'SUVAS' developed with support from the Ministry of Electronics and Information Technology, Government of India, utilizes Artificial Intelligence to translate legal documents, judgments, and orders into multiple vernacular languages, enhancing accessibility for non-English speakers. It was launched in 2019 to promote the use of regional languages in judicial proceedings. Currently, it can translate English judicial documents, orders, and judgments into 11 Indian languages, including Hindi, Kannada, Tamil, Telugu, Punjabi, Marathi, Gujarati, Malayalam, Bengali, Urdu, and vice versa.[17] Since February 2023, artificial intelligence has been used to transcribe oral arguments, especially in Constitution Bench cases. A committee headed by an Hon'ble Supreme Court Judge has been established to oversee the translation of significant judgments from the Supreme Court and High Courts into vernacular languages.

This committee regularly meets High Court sub-committees, comprising Judges, to accelerate the translation process. By November 2024, 17 High Courts had already started e-High Court Reports (e-HCR)/e-Indian Law Reports (e-ILR). The AI Committees of High Courts have been directed to initiate the Central and State Legislation, Rules, and Regulations translations into regional languages for the various State High courts with the help of respective State Governments. This program is envisaged under the "access to justice" vision mentioned in the Constitution of India. As of 25.11.2024, 36,316 Supreme Court Judgments have been translated into Hindi language and 42,457 Judgments of Supreme Court have been translated into other 17 regional languages and the same are available on the e-SCR portal. However, no separate fund has been sanctioned to the Supreme Court for the translation project.[18]

During the IBA International Conference in Mexico City in 2024, Delhi High Court's Acting Chief Justice (ACJ) Manmohan revealed that the Supreme Court of India is in the process of introducing an AI tool called AI Saransh. Developed by the National Informatics Centre (NIC), AI Saransh is designed to generate concise summaries of pleadings, streamlining the process of highlighting key contentious issues in legal cases.[19]

**CHALLENGES**

Legal practitioners using AI face numerous challenges, with data privacy and data leakage being foremost among them. Additionally, client consent is required before uploading any personal information onto an AI platform, which can hinder the ability of input-driven AI to generate accurate results.

A technological skill gap persists within the legal sector in India, which may reduce efficiency for those not proficient in AI. Additionally, there is concern among legal practitioners, especially at the clerical level, that AI could replace their jobs, leading to unemployment. Many paralegals worry that their roles could become fully automated with the advancement of AI-enabled technology.

Many lawyers believe that human intelligence remains indispensable, even in repetitive tasks. Additionally, senior legal professionals often prefer to maintain established practices and may resist integrating AI due to the nuanced nature of their cases, as well as ethical and privacy concerns. In judicial predictions, AI-generated results can be biased because the datasets used to train the models may contain inherent prejudices. For example, the COMPAS algorithm used in the U.S. criminal justice system has been criticized for exhibiting racial bias in criminal cases.

Moreover, the installation of AI and ML systems represents a significant financial investment. Most of these AI-driven technologies are developed by foreign companies, making it difficult for small and mid-sized law firms to afford and access them.

Artificial intelligence has benefited legal practitioners in multiple ways. Both corporate and independent practitioners have been using AI for drafting, finding it time-efficient, as it can reduce drafting and summarizing time by half when aided by AI software. In terms of cost, AI is more affordable than employing and managing legal clerks. Additionally, the rate of inaccuracies has decreased with AI's use for grammar and spell checks. Although AI use for legal research is limited, it is expected to expand over time. According to an independent lawyer, online legal database software has rendered traditional books somewhat "ornamental" for preliminary research. However, for detailed case-building, books, and case laws remain indispensable.[20]

**FUTURE OUTLOOK**

The global legal technology market was valued at 24,800 crores in 2023. It is expected to increase from 26,550 crores in 2024 to 53,417 crores by 2032, reflecting a compound annual growth rate (CAGR) of 9.1% throughout the forecast period. The growth of the market is largely attributed to rising investments in technologies that automate and enhance legal processes, thereby boosting the productivity and profitability of law firms while streamlining their operations. Furthermore, the growing volume of legal data contributes to the rising AI market share. Justice D.Y. Chandrachud has argued that "Technology is relevant insofar as it fosters efficiency, transparency, and objectivity in public government. AI is present to provide a facilitative tool to judges to evaluate the work, the process, and the judgments.[21]" The implementation of AI tools has enhanced the efficiency and productivity of the Indian Legal System. This technological advancement not only accelerates the delivery of justice but also helps reduce regional and linguistic disparities in a linguistically diverse country like India.

While machine learning tools assist with tasks like research, contract review, and data-driven predictions, they cannot perform essential activities such as providing client advice, negotiating terms, or arguing in court. These critical functions require human intervention and cannot be replicated by machines alone. At a recent event, former Chief Justice of India, Justice S.A. Bobde stated, "We have a possibility of developing Artificial Intelligence for the court system, only for the purpose of ensuring that the undue delay in justice is prevented." He emphasized that AI will not replace the discretion of human judges, adding, "It is only the repetitive, mathematical, and mechanical parts of the judgments for which help can be taken from the machine learning system. We are exploring the possibility of implementing it".[22] The seeds of digitization and AI use in the legal sector are still far from reaching their full potential. Currently, AI is primarily used for repetitive tasks and basic functions like legal research, translation, and transcription, all of which still require human oversight. Rather than perceiving AI as a threat, legal practitioners should view it as a low-cost assistant for reviewing their work. With continued technological advancements, AI may eventually develop the sophistication required to build stronger and more nuanced cases with minimal errors.

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# SPORTS AND FITNESS

## INTRODUCTION

The fast-evolving sports and fitness industry is catalyzed by rapid advancements in artificial intelligence (AI). From physical training and strategized game design, the application of AI now extends to performance analysis, event management, and fan experience, thereby reshaping the dynamics of the sector altogether. In India alone, it was estimated to be valued today at INR 15,766 crore—a near-fourfold growth over the last ten years—growing annually by 11% (GroupM ESP Sporting Nation Report 2024).[1] Despite India's growing investments in AI-driven sports technology, unique challenges remain. A significant portion of Indian athletes, particularly at the grassroot level, lack access to cutting-edge AI tools due to high costs and limited digital infrastructure. However, India's rapidly expanding sports ecosystem, coupled with government initiatives such as Khelo India and Digital India, presents immense opportunities. Integrating AI into these initiatives has the potential to democratize access to sports technology, enhance talent identification at the grassroots level, and strengthen India's position as a global hub for AI-driven sports innovation.

This paper explores the extent of AI adoption in the sports and fitness industry. As AI's role expands, understanding its applications across performance analysis, game analytics, and in generating personalised workout and nutrition plans becomes essential. A wide usage of AI was seen in Paris Olympics 2024[2], where it enhanced refereeing, event management, and fan experience[3]. Moreover, the 2023 Union Budget of India saw an 11% increase in the allocation for sports, signalling a national focus on creating a robust sporting ecosystem that leverages technology for excellence[4]. These developments are particularly timely as India looks to elevate its global sporting profile. Hence it is important to study the level of AI integration in the Indian sporting industry. The following sections focus on the areas where AI has been adopted in the sports industry in India, illustrating its impact, challenges, and the future outlook for the sector.

### AI USED IN PERFORMANCE ANALYSIS

The era when athletes relied solely on their natural talent, ignoring physical preparation, nutrition, and recovery is long gone. The integration of advanced technology and a data-driven training approach has transformed the world of sports. Among these innovations, AI has emerged as a prominent tool, widely utilised to enhance various facets of an athlete's training regimen. Its key applications include strength training, weightlifting, overall fitness, and technical training work through AI coaching tools.[5] By equipping athletes with AIoT (artificial intelligence of things) motion sensors—such as patches or wristbands—on their limbs and on the exercise machines, vital physiological data is collected from exercise and integrated with a real-time Open Pose system that analyses the athlete's posture, technique, shots during training sessions.

The digital coach's ideal movement pattern is merged with the trainees' creating a virtual simulation model for the athlete to also understand his/her innate movement patterns, determine levels of fatigue and reduce the potential risk of injury. This basic technology is used in various sports and fitness regimes in India as well as abroad to help improve the performance of a player. A renowned sports and exercise science specialist verified in an interview that AI is instrumental and comes in handy in enhancing players' physical fitness and performance.

In this context, IIT Madras is developing smart training solutions to help India bag at least 25 gold medals in the next ten years under the TOPS program under the Government of India.[6] Prof. Mahesh Panchagnula, CESSA, IIT Madras, mentioned various innovations that the centre was undertaking including a combat sports lab, a performance model for archery, 'low-cost custom imaging', a wearable sweat monitor, a wearable ultrasound monitor, a 'smart-boxer', ball-fight dynamic models, force plates, hyperbaric oxygen therapy and food scanners.[7] The 'smart boxer' captures every move through cameras and analyzes that data to provide inputs to boxers to improve their performance. This platform is in application at the Inspire Institute of Sports (IIS) in Vijayanagar where boxers are monitored through this system developed by CESSA.[8] It is also being used by the best boxers in India at the national level.

The IPL Team, Royal Challengers Bengaluru (RCB), is actively incorporating artificial intelligence (AI) and data analytics to enhance player performance using technologies developed by IIT Madras. Use of AI is seen in the case of cricket bats. The CEO of a sports tech company emphasized that' 'what you cannot measure, you cannot improve.' This technology is a sticker motion sensor without a camera that enables bats to provide the player with data and stats that help improve their performance. Rajasthan Royals is currently using this tech in their training sessions.

One of India's most successful bowlers, Anil Kumble's venture, Spektacom in Bangalore, has innovatively utilized non-intrusive sensor technology on cricket bats to integrate data from their power bats with insights derived from cloud-based data analytics, machine learning, and AI.[9] Moreover AI also helps performance analysis by generating rankings that come in handy for players to analyze their opponents.

ESPNcricinfo has unveiled the 'Player Impact Score' based on a Sports Analytics Algorithm developed by IIT Madras. Jonty Rhodes, a coach for IPL teams, explained: 'We analyse patterns in the power play, middle overs, and death overs separately and collectively. Factors like strike rate, runs scored, and wickets taken guide our strategy-building process. "He further highlighted that during the pandemic, when players trained in isolation, AI-based neurological feedback systems became an efficient coaching tool".[10] India's table tennis coach Massino Costantini has revealed that the use of technology and Artificial Intelligence are helping Indian players get better before the Paris Olympics.

The Indian team is partnering with the Indian sports analytics company Stupa Sports Analytics for a training camp. [11] Moreover, the International Table Tennis Federation (ITTF) has also signed an agreement with an Indian startup, Stupa Sports Analytics that uses AI-enabled ball tracking and video analytics to provide real-time match and practice analytics solutions to leading players in all of its 226 member associations (countries).[12]

The administrator at a prominent tennis Academy spoke about AI sensors being used in tennis racquets in the academy and other elite institutions to better analyze the performance of the player. However, the use of AI-enabled tech is restricted at the highest level, with only national-level players of renowned sports in India being able to access it. The 'chip racquets' which are available in the market aren't that expensive and can be adopted widely in tennis academies to gain a more qualitative insight. However, it is only ancillary to a coach's input, which drives a player's chances towards a win, he stated. Moreover, he also spoke about Infosys having an entire tennis-centred sports tech unit in Bangalore- ATP, and its collaborations with world-class tennis players. The founder of a computer vision tech company for racquet sports stated that AI has the potential to democratize sports through in-depth performance analysis during matches.

AI technology is also transforming sports by converting 2D analyzes into 3D simulations, using sensors to study anatomical body movements. The founder of a Gold academy mentioned that AI is extremely beneficial for sports mocks. Golf has been a perfect prospect for AI adoption in training, given its more static nature and having fewer external variables, as it is a non-contact sport.[13] Here wearable devices, sensors capture full body motion and store data, which can be revisited for review, he stated. For instance, the two-time Olympian, Aditi Ashok, received approval from the Sports Authority of India's Mission Olympic Cell to acquire a Trackman4 launch monitor ahead of the Paris Olympics 2024.[14]

This technology uses optically enhanced radar tracking (OERT) to capture the impact location on the clubface and track ball flight. For shooting too, Pierre Beauchamp, the high-performance director for the National Rifle Association of India, emphasised the importance of data management using AI. He highlighted that the 'Data management was previously overlooked or not taken seriously, particularly in Indian shooting. I am looking at numbers in everything and am heavily interested in data analytics and how it can support decision-making for the organization'.[15]

The introduction of AI-enabled platforms has significantly increased user engagement in chess in India, for example, Mumbai-based Square Off offers physical chess boards with adaptive AI integrated with automated movements. They are also planning to launch AI/ML-based 'coaching' software that will be compatible with existing chess boards.[16] While interviewing another senior executive of leading sports tech startup, he highlighted the use of machine learning and AI across sports through GOAT vision.

This is being used in the various swimming centres that the company has established, but also in renowned sports training institutes like the Gopichand Badminton Academy, Rohan Bopanna Tennis Academy, Sharad Kamal Table Tennis Academy and Saurav Ghosal Squash Academy for enhancing player performance and game analytics, especially for scouting. However, he noted that many coaches remain hesitant to adopt AI in their training methods. He explained that while setting up AI-enabled tech in sports is relatively affordable, the high costs of R&D and model training remain a significant barrier.

AI use in team sports helps a team improve its performance using wearable devices and performance analytics.[17] From our interaction with various individuals in Sports, we have noted that coaches and scouts are also using AI-based analytics for selecting teams. The All-India Football Federation launched the first of its kind pilot project across four states in collaboration with the German organization Kick ID to identify talents through data science and analytics, using contemporary cameras and Artificial Intelligence (AI) technology. Kerala, West Bengal, Mizoram, and Punjab are the four states in which the pilot project was launched. The players in India, through this program, will also be compared with the corresponding age groups in Europe and Africa in a 5v5 game environment.[18][19] Another case of the use of AI in sports is predictive models that estimate match outcomes and player performances by examining historical data in conjunction with game trends. A case in point is where machine learning is used to analyze winning probabilities in the Pro Kabaddi League.[20] This ability enables teams to develop strategies effectively based on expected scenarios.

However, AI adoption remains limited, particularly in non-team sports. This is because it is still an expensive feat to integrate AI into the practice sessions. He suggested that with more users, the cost will become viable, and it is then that AI will truly be a part of the sports industry. This will require coaches to break old habits and change their attitudes towards a data-centric approach. He also spoke about focusing on tactical data rather than technical data while making use of AI like they do in the game of squash, giving out shot, posture, speed analysis, and substantiating it with video highlights using camera vision technology.

AI's applications in sports extend beyond performance enhancement. It is also used for game analytics, scouting, and refereeing which are the topics explored in the next section.

## AI USED IN GAME ANALYTICS

Rules, fair play, and accurate umpire decisions are fundamental to any sport, requiring transparency and impartiality in decision-making. AI minimizes human error and is a step towards enhancing integrity in sports.

The Badminton World Federation (BWF) employs Hawk-Eye Innovations to provide instant reviews, pinpointing the exact landing spot of a shuttle during major events. This tracking system debuted in badminton at the India Open Super Series. [21]

In cricket, Hawk-Eye is integral to the Decision Review System (DRS), used in Indian domestic tournaments like the Duleep Trophy[22], and in IPL as well as in international matches. Moreover, AI is also being employed for coach selection in India. The Sports Authority of India (SAI) used artificial intelligence to conduct an online exam for aspiring coaches from India, Nepal, Bangladesh, and Malaysia. The exam was conducted following an extensive 21-day online 'Coach Education Programme' amid the COVID-19-enforced lockdown in 2020.[23]

AI's applications in sports extend beyond competitions and practice sessions for game analytics to player aftercare as well, including injury risk prevention and nutrition, as detailed in the next section.

## AI IN INJURY PREVENTION AND RECOVERY

Every athlete has a unique physique, specific requirements, and varying metabolism. AI's predictive capabilities help design personalized workout regimens and nutrition plans where specific exercises are more impactful, suiting the players' body type. This not only proves to be more efficient for an athlete, saving time and energy but also significantly reduces the risks of injuries. Top teams record and track players' data over long periods of time and analyze it using AI tools to determine their average workload capacity, and when an individual has surpassed it. This comes in handy to minimize stress-induced injury risks.

A sports exercise specialist noted that AI is highly effective in formulating workout plans tailored to a player's physiological capabilities. This helps minimize 'overuse injuries.' However, acute injuries still can't be predicted. The use of AI is more in team sports, since there is a lot more data to be considered and processed, he stated. AI-powered diagnostic tools use algorithms that significantly reduce the margin for errors to identify injuries, enabling better treatment options for athletes. Currently, AI algorithms have the capability to determine bone density, detect fractures, and perform differential segmentation for lesions.[24] The use of AI in ascertaining the progress of recovery and a player's return to the field by measuring ground reaction force (GRF) is a case in point.[25] This indicator is generally used in the recovery of knee injuries, where a lower GRF score indicates the need for extended recovery time. AI also assists nutritionists in formulating diet plans tailored to individual needs, body types, and metabolic rates. A renowned sports dietician stated that new-age dieticians in India are using AI for processing calorie data, as they find it strenuous to process data three times a day and integrate it with practice sessions and performance figures for several weeks, to formulate suitable diet charts.

However, she emphasized that no existing application can provide completely accurate results. She stated that over time, the costs for AI-enabled paid platforms have certainly come down, however, there is a need to upskill dietitians to get attuned to them. Nevertheless, AI cannot be fully relied upon for providing dietary consultations. Beyond game analytics and player performance, AI plays a significant role in enhancing fan engagement, as explored in the next section.

## FAN ENGAGEMENT

AI-driven analytics provide insights into fan preferences and behaviors, enabling sports organizations to tailor content, promotions, and interactions. This targeted strategy enhances fan engagement and loyalty by providing them with what they find most appealing.[26] AI algorithms analyze viewer behaviors to deliver personalized content recommendations and targeted advertising. This expands marketing opportunities for the sports sector.

Prisma AI partnered with the Jaipur Pink Panthers in the Pro Kabaddi League to use Veri5, an AI-powered facial recognition system. This transformed the spectator experience by enhancing fan engagement, streamlining venue access, and improving security.[27] FC Goa has become the first Indian football team franchise to launch an interactive AI messenger service on Facebook. The 'GaurBot' enables fans to engage in real-time interactions throughout the season. The bot is part of FC Goa's '#WriteOurWin' campaign that encourages fans to send customized messages to the players, which then will be displayed in the promotional activities that the club undertakes.[28]

Moreover, networks like ESPN utilize AI to provide real-time game insights, enriching the viewing experience and engaging audiences through comprehensive game summaries, player profiles, and predictive analyses. Indian Institute of Technology Madras (IIT-M) and ESPN's 'cricinfo' artificial intelligence (AI) tool 'Superstats' is enhancing the fans' experience during the Indian Premier League (IPL) matches. This tool offers three major metrics of forecaster, luck index, and smart stats that cover all aspects of the match for fans, covering pre-game, in-game, and post-game.[29] Another example of AI enhancing fan engagement would be Maharashtra-based Quidich Innovation Labs that adapts cutting-edge, robotic camera technology to capture never-seen-before angles of live sports.[30]

The Indian Fantasy Sports (FS) Industry is experiencing significant growth over the past few years. With a market size of over INR 34,000 crore, buoyed by strategic investments, the industry now caters to over 13 crore registered users.[31] AI helps users in game predictions, choosing their teams and improving user performance. This predictive capability of AI is also being used in case of betting in sports. Given AI's growing role in sports betting and predictive modelling, India must establish comprehensive frameworks and regulatory bodies to ensure transparency and fairness.

While the various uses of AI in the sports sector have been explained, there are numerous impediments that restrict its use. The next section tries to explore them.

## CHALLENGES

Athletes, coaches, nutritionists, and fitness specialists using AI face many challenges. A sports exercise specialist, during our interaction, asserted that sports is more about the person than the process. While AI can help improve a player's fitness and physiological performance, victory also depends on their mindset and technique. The latter two components can only be enhanced with help from coaches.

A behavioral hesitancy is also apparent in the Indian Sports industry in the context of AI adoption. Prof. Mahesh Panchagnula stated, "While most of the Western countries are exploiting AI in the sports arena, in India, most coaches are still reluctant to adopt AI, relying solely on manual expertise. There is significant hesitancy for AI adoption in India at the top of the pyramid itself." He also emphasized the need for upskilling coaches, stating, 'while AI might not replace coaches, but coaches who are well equipped with AI might replace the coaches reliant just upon traditional coaching methods.'AI systems in sports require extensive data collection, including health metrics, performance statistics, and personal information, raising concerns about potential data leaks. It also has the potential to identify users even when the algorithm relies on de-identified data. This has added to the skepticism of coaches and athletes. It is crucial to find a balance between utilizing these technologies and safeguarding athletes' privacy.

Moreover, it is an expensive affair to integrate AI-enabled technology into practice sessions, courts, or an academy, stated the administrator of a renowned tennis academy. This has not led to the inaccessibility of AI tech to players at the grassroots level. A sports dietician and an exercise expert also spoke about the mismatch between the AI innovations coming up in the field of sports and the needs of a coach/player. They stated that although many startups are emerging in the sports tech sector, their products often lack widespread adoption due to limited use, resulting in reduced demand.

Despite its challenges, artificial intelligence has helped athletes, coaches, and dieticians improve their overall performance. AI processes vast amounts of data that would otherwise require considerable time and effort if handled manually. AI helps coaches to focus on each player of the team or an academy instead of just prioritizing star performers. Apart from player performance, AI helps make quick decisions in game analytics as well. It assists referees and coaches in decision-making when they are in flux. According to a professor of CESSA, IIT Madras, AI upskilling can make India a sought-after destination for athletes to train by democratizing sports even further. In the coming years, it will be essential for athletes and coaches to adapt to the growing role of artificial intelligence to truly make India a global hub for sports.

## FUTURE OUTLOOK

The sports industry has seen a remarkable transformation with the adoption of technologies like AI, revolutionizing how sports are played, analyzed, and experienced. Globally, the sports tech market, valued at INR 1.82 lakh crore in 2022, is projected to grow at a CAGR of 13.8%, reaching INR 3.48 lakh crore by 2027. In India, the sports-tech sector, worth INR 9,900 crore in 2022, is expected to expand at a CAGR of 24% over the next five years.[32] Indian chess legend Viswanathan Anand, in collaboration with Tech Mahindra, shares optimism about the future of chess, technology, and engagement. In an interview with the Times of India, he remarked that AI has fundamentally transformed the game's dynamics, stating that it is something one cannot resist. Anand believes that AI is continuously reducing the cost and effort required for training, making advanced methods accessible via computers and mobile devices.

AI technologies are revolutionizing sports by enhancing player performance, managing operations, engaging fans, and improving a team's ability to win matches. It not only makes coaching more inclusive, but it also personalizes user and fan engagement. With the increasing volume of data being collected, AI systems continue to enhance their intelligence and accuracy, empowering teams and coaches to develop more effective strategies by analyzing opponent data and making real-time tactical adjustments.

Despite its potential, AI-based tools pose concerns about privacy and are an expensive affair. It is essential to enrich the datasets that AI relies on to provide accurate guidance to athletes. However, the personal relationships that are vital for the motivation and morale of players are compromised if interactions become predominantly data-driven. To fully harness the benefits of AI in sports, it is essential to carefully balance technological advancements and human interactions. Collaboration between AI systems and human expertise can enhance decision-making while preserving the personal connections integral to sports. As technology advances, AI integration in sports will continue to grow, unlocking exciting and innovative possibilities. From grassroots programs to professional leagues, the sports industry is set to harness AI's potential, ushering in a new era of excellence.

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# TOURISM AND HOSPITALITY INDUSTRY

## INTRODUCTION

Tourism and hospitality industry worldwide is undergoing significant transformation, with annual spending on Artificial Intelligence (AI) in the sector projected to reach approximately $2.6 trillion to $4.4 trillion.[1]

As AI technologies advance, they offer immense potential to enhance the industry by providing data-driven insights and creating tailored experiences for over one billion global travelers annually.[2]

Aligned with these global developments, India's tourism and hospitality sector has begun integrating AI into its operations, thereby reducing reliance on manual processes. Increasingly, customer interactions are increasingly being automated ensuring streamlining of operations and personalized recommendations. These advancements have significantly contributed to the sector's growth.

Adoption of AI in tourism has also been highlighted in the Annual Report of the Ministry of Tourism for 2023-24. This report emphasized initiatives aimed at enhancing digital infrastructure for travel planning, operational efficiency, and fraud detection.[3] Notably, the report recorded a substantial growth of 68.8% in the arrival of arrival of foreign tourists, from 6.44 million in 2022 to 9.24 million in 2023. This growth can be partly attributable to AI-driven transformations and digital campaigns.

Development in AI within the tourism sector is also influencing the broader impacts the broader economy of India. According to a report by India Brand Equity Foundation the Indian tourism industry is projected to generate a revenue of nearly Rs 2,400 crores in 2024, with a steady annual growth rate of around 9.6% between 2024 and 2028 focusing on creating a world-class infrastructure.[4]

As the sector is at a nascent stage of AI adoption and focused on attracting travelers through AI-driven platforms, a McKinsey study suggests that AI intervention will lead to an annual 9% growth in domestic travel spending, positioning India as the world's fourth-largest domestic tourism market by 2030.[5]

This report explores the role of AI in reshaping India's tourism and hospitality industry. It examines its impact across areas like guest experience, revenue growth, business travel, online booking systems, and state-sponsored tourism initiatives while identifying opportunities and challenges that AI presents.

The first section of the report assesses the impact of AI on enhancing guest experiences and offering personalized recommendations.

## AI IN ENHANCING EFFICIENCY AND GUEST EXPERIENCES

Artificial Intelligence continues to transform India's hotel and hospitality sector by integrating AI-powered tools such as facial recognition and machine translation into their automated processes to enhance guest experience. One notable example is Taj Hotels (IHCL), which uses i-Zest, a zero-touch service suite, across its brands to enable contactless service and automated invoicing.[6] The General Manager of the Mumbai branch shared that the hotel has incorporated facial recognition for staff attendance, Opera Cloud for data-driven predictive modeling and Tata Intelligent Assistant (TIA) for handling booking-related queries. Over the years, TIA has managed over 60% of these queries reducing response time by 50% and improving customer satisfaction. Their current transition focuses on integrating location-based AI-driven marketing and AI cameras designed to respect privacy, further streamlining and digitizing operations.

Similarly, hotel chains like Oyo have deployed machine learning programs to optimize room pricing based on demand patterns, ensuring better deals for guests. The manager of an OYO hotel in Delhi stated that the implementation of OYO OS, the hotel's proprietary AI platform, led to a 15-20 percent increase in revenue and peak occupancy levels due to automated customer service in 2023. This platform also led to a 40 percent increase in visibility and repeated bookings by improving the speed and efficiency of customer interactions. Through advanced data analytics, it identified guest preferences and provided personalized recommendations. OYO OS exemplifies how AI-driven solutions can transform hotel operations, leading to revenue growth, customer retention, and enhanced efficiency.

Adoption of AI is not limited to just metropolitan cities. The General Manager of a leading hotel chain in Lucknow highlighted that Online Travel Agencies (OTAs) are increasingly managing hotel bookings with AI-powered systems. These technologies also assist with housekeeping schedules and incorporate dynamic pricing algorithms with the hotel's property management system (PMS) to optimize occupancy rates and forecast staffing plans. These automated processes have not only improved operational efficiency but resulted in a room-to-employee ratio of 1:1.

Guest relations have also improved significantly with the implementation of AI tools like Customer Relationship Management (CRM) for personalizing guest experiences by automating profiles based on preferences for dining, room settings, and other activities.[7] A Resident Manager of a prominent hotel in Ahmedabad affirmed that these tailored recommendations and enhanced security systems have increased guest loyalty. Subsequently, the increasing adoption of AI-driven processes in hotels has led to automated revenue management systems and the use of predictive analytics for dynamic pricing. These innovations have contributed to improved economic growth, which has been discussed in greater detail in the following section.

## AI IN LUXURY HOTELS: INNOVATIONS AND REVENUE GROWTH

Along with AI, hotels are now turning towards robotics to further enhance efficiency of their operations.[8] A 2023 report by NASSCOM indicated that integrating robots in hotels boosted operational efficiency by 10-12%, enabling the workforce to focus on more complex, value-driven tasks. Robotics companies such as Milagrow and Universal Robots have reported growing interest from the Indian hospitality industry, particularly for collaborative robots (cobots) capable of performing tasks such as cooking and cleaning.[9]

Senior employees in the hotel IT departments state that while the initial set-up cost for AI systems and robots is high, these technologies have automated repetitive tasks and addressed labor shortages. Furthermore, given the low adoption rate of AI in hotels, they predict that over the next 5 years, the increasing demand for technology-enhanced guest experiences could result in annual revenue growth of around 20 %. This growth is expected to offset the initial investment costs. Hotels are anticipated to gradually adopt AI-driven solutions such as smart room features and predictive analytics to improve customer satisfaction and attract tech-savvy travelers.

A similar trend was noted by the Sales Department Manager of a luxury hotel in Delhi, who shared that AI has been integral to their operations for the past five years, facilitating faster-automated response, strategic time management, and enhanced forecasting of investment trends. The hotel reported an impressive annual revenue growth of 30%, attributed to AI, and projected that reliance on such technologies would double over the next decade.

With the growing recognition of AI, hotel chains are leveraging AI-driven automated revenue management systems to identify investment trends, predict dynamic rates, and improve overall business understanding. The Resident Manager of a premier hotel in Goa explained that their hotel operations are now largely guided by AI-driven software. The hotel deploys Easy RMS, an automated revenue management system, that has streamlined account management and increased revenue by approximately 30% over the past two years. It also assists in projecting seasonal booking rates, thereby enhancing profitability.

The concept of creating the ‘smartest tech hotel’ and transforming several departments into AI-driven operations was discussed by the CEO of one of the India’s largest hotel chains. He revealed that the hotel has implemented facial recognition software, enabling staff to receive a personalized greeting from an AI voice during attendance registration. Additionally, the hotel has adopted AI software like RevoX and VersionX to meet its hotel management requirements, contributing to an annual increase in revenue of around 15%. The chief executive highlighted the positive reception of these AI-driven experiences, noting the subtle excitement among guests for technological innovations.

The growing adoption of AI in the hospitality industry has led to the expansion of online booking systems and the integration of chatbots by travel agencies to enhance customer interactions. The following section explores its influence on predictive booking trends and customer preferences.

## AI IN TRAVEL AGENCIES: ONLINE BOOKING SYSTEMS AND CHATBOTS

The emergence of AI in the tourism sector has significantly transformed online booking and travel planning by introducing chatbots and virtual assistants. These technologies not only understand tourists' preferences but also offer personalized packages. AI-driven algorithms are also being widely applied in booking systems, which now suggest cost-effective deals on destinations, travel, and accommodation.

Platforms like MakeMyTrip reported a 63% quarterly increase in gross bookings, totaling Rs 160 crores in 2023, driven by AI-powered predictive booking recommendations and voice-activated searches.[10] Employees at the travel agencies predicted that the Online Travel Agency (OTA) industry in India, which combines Artificial Intelligence (AI) with the Maximum Likelihood Method (MLM),[11] is projected to grow at approximately 13% annually. By leveraging machine-learning algorithms, these platforms offer personalized travel suggestions based on user preferences, browsing behavior, and booking history.[12]

Ixigo, another AI-powered booking platform providing tailored travel packages, recorded approximately 400 million annual active users and 76.78 million monthly active users by October 2024.[13] Its chatbot, Tara, handled nearly 89% of customer support queries, ensuring seamless service delivery.

Travel agencies have also enabled AI services to expand their reach. Thomas Cook India focuses on enhancing spiritual tourism in tier-two cities by adopting AI, VR, and AR in their operations, allowing staff to dedicate more time to complex activities and customer interactions.[14]

The emergence of AI-powered chatbots has further strengthened the tourism industry. For example, Dottie, a chatbot of IndiGo Airlines, assists tourists with booking flights, preparing stays, and making modifications based on their preferences.[15] According to a 2023 Outgrow report, chatbots can resolve upto 90% of tourist queries. The AI market in India is projected to expand at an annualized rate of 25-35% between 2024 and 2027.[16] Additionally, AI and Generative AI (GenAI) adoption in the tourism industry is estimated to have reached 65%, significantly enhancing personalized experiences and driving sectoral growth.[17] To address the needs of India's multi-lingual population, the Government of India (GOI) has introduced Bhashini, an AI-powered language translator.

This initiative aims to overcome the language barriers in online bookings, enabling cross-border travel by automating language translation and processing. This innovation has made travel planning more inclusive and accessible.

However, India still has significant progress to make in digitizing of hotel bookings. A 2017 report by BCG noted that developed countries like the US and the UK have digitized more than 50% of their hotel bookings, whereas in India, only about 20% of bookings are made through online systems.[18]

These AI-driven processes have not only personalized individual travel packages but also facilitated easier business travel and contributed to economic growth, as elaborated in the next section.

## AI IN BUSINESS TRAVEL

Developments in AI have been extensively leveraged for business travel, allowing rapid transactions and effective demand-oriented services. A 2018 study by Tata Consultancy Services (TCS) reported that approximately 85% of business travel providers in India have integrated AI into their operations.[19] Driven by AI technologies, concepts such as smart tourism now include Virtual Reality and Augmented Reality experiences, offering immersive explorations of destinations.

Tripeur, an AI-based business travel startup now acquired by Navan, a renowned multinational corporate business travel agency. They are transforming business travel management through Artificial Intelligence and Machine Learning algorithms in India. The platform focuses on delivering exceptional traveler experiences, achieving significant cost savings, and streamlining administrative tasks for employees and executives. According to a senior company representative, India's corporate travel economy is projected to grow at an annual rate of approximately 12%.

In addition to private companies incorporating AI into their operations, several states have adopted digital technologies and introduced automated services, such as virtual tours of key destinations. These state-sponsored initiatives are explored further in detail in the subsequent section.

## STATE-SPONSORED AI INITIATIVES IN TOURISM

Introduction of AI into state tourism initiatives has significantly boosted revenue by optimizing resource utilization and enhancing tourist experiences. AI applications such as DigiYatra, used at airports for digital identification, have simplified and made travel more accessible. Additionally, AI-driven chatbots have been integrated into government tourism service providers to gather insights into tourist behavior and preferences, enabling personalized and efficient service delivery.

The Department of Tourism in Kerala uses Maya, an AI-powered chatbot, to address tourist queries, improve travel facilities, and enhance the overall tourist experience. Such technological integration has streamlined processes, improved service quality, and supported the long-term sustainability of state tourism industries.[20] Furthermore, sustainable tourism initiatives have gained momentum through AI-powered campaigns like Incredible India, amplified by collaborations with the private sector.

State tourism departments have also adopted AR/VR technologies at several centrally protected heritage sites, offering immersive experiences for visitors.[21] A standout example of this fusion of traditional knowledge with AI is the transformative project, "Tales of Ajanta – VR Experience". This initiative brings the timeless beauty of the Ajanta Caves to life through cutting-edge virtual reality. Developed under the Science Heritage Research Initiative by the Department of Science and Technology (DST), in collaboration with IITM Pravartak Technology Hub and the Archaeological Survey of India (ASI), it leverages advanced 3D scanning, modeling, and animation. These initiatives aim to increase tourist influx, drive economic growth in the digital era, and ensure future generations can experience these cultural treasures, even without physical visits.[22]

Other notable programs, such as Dekho Apna Desh, utilize AI-driven tools to promote lesser-known destinations across India, aligning with the Tourism Ministry's vision for a comprehensive digital tourism framework. Additionally, drone technology and digital mapping are being used to monitor protected archaeological areas, enhance surveillance, and address encroachment issues at lesser-known tourist destinations. These measures help unlock tourism potential while safeguarding India's cultural heritage.[23]

Moreover, schemes like Swadesh Darshan 2.0 and the Pilgrimage Rejuvenation and Spiritual Heritage Augmentation Drive (PRASHAD)[24] have deployed AI-driven information kiosks at over fifty destinations. These initiatives aim to enhance visitor experiences, promote sustainable tourism,[25] and focus on supporting local economies and cultural resources.

The integration of AI into the tourism and hospitality industry has progressed steadily, with a consistent emphasis on balancing human interaction and AI adoption to navigate ethical complexities in the digital age.

## BALANCING AI AND TECHNOLOGY WITH THE HUMAN TOUCH

Despite the increasing adoption of AI in hotel operations to improve efficiency, a reoccurring concern among senior managerial staff is that the quality of service still relies heavily on human intervention. This presents a significant challenge for the hospitality industry, which must balance Artificial Intelligence (AI) and Emotional Intelligence (EI) while remaining fundamentally people centered.[26]

A good example is that of the integration of RFID (Radio frequency identification) devices for contactless services and the efficient guest database management has enabled digital check-ins through mobile keys powered by AI-driven software. However, around 40% of hotels have been hesitant to adopt this technology due to challenges such as software downtime, guest privacy concerns, and algorithmic errors.

Similarly, AI cameras and robots deployed for automated guest alerts and service responses have been adopted by only 20-30% of Indian hotels. This low adoption rate reflects a belief that 'faceless' hotels cannot improve the visitor experience in a country where personalized interactions are highly valued. According to a report by the Federation of Hotel and Restaurant Associations of India (FHRAI), while AI-driven systems improve operational efficiency, the absence of human interaction can reduce customer retention rates by nearly 15%. Guests increasingly expect not just technological solutions but also emotionally engaging, high-quality service.[27]

While it is clear that AI and technology and AI represent the future of the tourism industry by maximizing profits, boosting overall performance, and enabling trend analysis, there is also a growing recognition that replacing employees with robots risks undermining the core essence of hospitality. Human interaction in the hospitality industry remains indispensable, as AI systems are inherently limited to predefined inputs and responses. Guests continue to expect seamless integration of advanced technology with emotionally resonant, good-quality service.

## CHALLENGES

While the adoption of AI in the tourism and hotel industry offers numerous benefits, it also presents significant challenges. Although AI has enhanced efficiency and strengthened the industry, it is not a universal solution. A critical concern is the displacement of traditional roles due to AI-driven automation, which has reduced the demand for certain positions. For instance, a sales coordinator at a renowned hotel in Delhi noted that integrating AI for managing business trends and predicting sales has resulted in a 10 to 20% reduction in hiring within the department. He also cited guests' apprehensions about risk of hacking and other cybersecurity threats associated with advanced technology.

Financial and infrastructural challenges further hinder the widespread adoption of AI systems. These issues are exacerbated by regulatory gaps stemming from inadequate policy interventions. Hotel employees often report difficulties in integrating AI-driven operations, particularly when these systems are developed by foreign companies, are not fully compatible with existing Indian hotel management systems. While AI can be a game changer for budget hotels, luxury hotels will continue to depend on human oversight to deliver exceptional personalized experiences.

These challenges underscore the need for balancing technological innovation with robust cybersecurity measures, effective policy interventions, and a sustained commitment to preserving the human touch in the industry.

## FUTURE OUTLOOK

The emergence of artificial intelligence has been transforming the tourism and hotel industry by accelerating revenue growth, streamlining operations, and personalizing guest experiences. Globally, the adoption of AI in the hospitality sector has risen significantly, with 77% of major hotel chains using predictive modeling to optimize resources.[28] However, in India, the AI market in the sector is projected to reach surpass the $1.2 billion mark by 2026.[29] Alongside the adoption of AI-driven systems, there is a pressing need to initiate targeted training programs for employees to ensure that the benefits of AI extend beyond businesses to the workforce.

Over the years, both private and state-sponsored AI initiatives have reshaped the tourism industry by incorporating AR/VR experiences for tourists and easing accessibility to hotels. However, the integration of AI in India remains far behind the advancements seen globally. Currently, AI is predominantly employed for basic functions that still require human oversight to ensure quality and reliability.

To harness the full potential of AI, India must promote inclusive and responsible AI practices. These should address concerns around data misuse, establish a secure ecosystem, and focus on delivering enriched tourist experiences while reducing operational costs. By leveraging these advancements, India has the opportunity to position itself as a global leader in innovation in the tourism sector, seamlessly blending the irreplaceable human touch with technological sophistication.

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# URBAN PLANNING AND CONSTRUCTION

## INTRODUCTION

The proliferation of large urban centers in the country has meant that huge populations of people have traveled across regions to find livelihoods in cities that have become a hub of many major industries and sprouting employment opportunities. While the percentage of the population living in urban areas was estimated to be 31 percent in 2011, recent research on satellite data indicates that this figure is close to 45% today, and is predicted to rise to up to 60 percent by 2050.[1] The settling of people in cities profits the economy, but this needs the aid of meticulously planned cities that are capacious for people to thrive and live comfortably. The increasing urban population requires cities to expand and develop simultaneously, making urban planning and construction a formidable challenge.

Today, as more people migrate to cities, urban planning, and construction processes acquire more salience. Our cities also generate large amounts of data which is available for analysis and the development of demand-specific infrastructure. AI has enabled the optimal use of this data through its potential to streamline, read and analyze datasets to inform decisions in urban planning and physical infrastructural development. Its use in predictive analysis and generative design has helped leverage the now available data for city planning and infrastructure.

Within the construction sector in particular, the usage of AI in the construction market was forecasted to grow from 1.37 billion dollars in 2023 to 1.79 billion dollars in 2024 at a CAGR of 31.1%.[2] KPMG's Global Construction Survey 2023 - India Edition, revealed that a similar trend of growth could be noted in India with 37% of the respondents (119 India-based primary survey respondents in leadership roles across project owner firms and engineering and construction firms, from both public and private sectors) indicating that they were either continually adopting or had just begun adopting AI. Of these, 56% of respondents felt that the use of AI solutions was more important in capital projects and 44% of respondents believed that the adoption of AI by their organization reflected an improvement in reducing costs or avoiding overruns by 10% or more.[3] Analyzing the aforementioned trends within urban planning and construction, this chapter details the adoption of AI through a process-specific break-up of the same.

## AI ADOPTION IN URBAN PLANNING & CONSTRUCTION

Intending to create close to 100 smart cities, the Government of India invested in mobilizing technology under the Smart Cities Initiative.[4] The adoption of AI in our cities has been at the heart of the transition from smart to intelligent cities capable of making sense of the now available datasets, transforming them into predictive intelligence to navigate urban operations and construction.[5]

AI and Machine Learning systems available in the industry continuously collect, sort and analyze data from various sources such as satellite imagery, IoT devices, social media, drones and sensors, and transportation and waste management systems to gain insights into population trends, traffic patterns, energy consumption and environmental considerations.[6] Further, beginning from using data for site assessment, ideation and visualizing infrastructural needs to fine-designing urban plans and layouts and ensuring sustainable use of resources in construction and reducing costs, AI has aided it all.

## LAND USE MANAGEMENT

Land administration and management play a crucial role in city planning, ensuring the judicious and strategic use of land resources. It is a layered process involving diversity in language, culture, regions, topography, nomenclature and socio-economic factors.[7] Therefore, assimilating data based on multiple vertical and horizontal hierarchies is as time-consuming as it is important in urban centers.

In the past, digitization of land records has enabled its accessibility and placed it in the public domain through govt portal of land records and GIS mapping. Seamless access to land records increases the efficiency of public service delivery by solving issues of uniformity, interoperability and compatibility of shared land records amongst various stakeholders. In consideration of this, DILRMP, a Government of India initiative was launched in 2016 to modernize land records management through an Integrated Land Information Management System. It is a tool to create a comprehensive and transparent land record management system for error-free and tamper-proof land records. It proposes adopting modern technology such as AI, Machine Learning and Blockchain technology thereby providing security of tenancy to citizens, reducing land disputes, simplifying the procedure of transfer of property title, assisting in policy and planning.[8]

## PLANNING & STRATEGY

Project planning within the construction of public and private infrastructure is a process that requires meticulous attention to complete tasks such as scheduling, resource allocation, and cost estimation. AI's aid in the process helps architects and builders not only complete projects in time but also practice judicious use of capital and resources by optimizing and streamlining the processes of gauging the availability of labor and resources, selection of the same in tandem with environmental conditions and market requirements and making project timelines.[9] This intervention helps in pushing sustainability efforts, reducing costs and creating robust physical infrastructure with longer lifespans. According to a professional at a leading multinational architecture firm with operations in Singapore and India, preliminary planning of projects requires a site analysis to assess the feasibility of the project development. Here AI is a useful tool for the project planner.

Spatial AI design tools such as GIS and CAD based AI tools, help create efficient spatial layouts by assessing the features of the environment, thereby determining the feasibility of construction. Citing the example of the construction of a parking lot, she explained how AI can be used to assess the contours (topography, resource utilization and traffic flow) of the parking layout. Images of the site can be fed to AI tools that show nearby structures. This information then allows the project developer to assess whether and how the project can be brought to fruition in that location.[9]

Commenting on the use of AI in creating and formalizing documents, she mentioned that bigger firms like theirs have been in architecture for several years having preset standards for project plans, schedules and contracts between the stakeholders. These were developed in times that preceded AI and are used to date. However, smaller firms that have recently opened up, formalize contracts and format documents using AI.

## ARCHITECTURAL DESIGN

Architectural designing has long been digitized by the introduction of Building Information Modelling (BIM) and 3D modeling technologies that have shifted paper-based drawings to the digital space.[10] Artificial intelligence expands opportunities offered by these technologies by enabling architects to create multiple design options quickly. It uses inputs like space specifications or physical constraints provided by the architect to generate and visualize different possibilities for evaluation. It also analyzes datasets such as existing building codes, site conditions and materials. Generative design optimizes existing designs by considering many variables to reach the desired outcome. It also leads to a reduction in time and use of human resources in designing.[11]

The director of DesignAware, an interdisciplinary design and experimental architecture studio shared about the firm's extensive use of generative AI for design research in the last couple of years. Most of the tools employed are diffusion models and large language models. They are informed by large datasets of images that are analyzed and understood through deep learning to create designs. These help generate realistic, fantastical, hyper-realistic or futuristic images per the requirements and are used by designers, architects and artists. Keyword commands or images can help design with very little effort now. AI then helps in two ways, either in visualizing a concept or quickly creating a design visualization that the designer already has in mind. She noted that last year, their firm participated in a competition called Regenerative Futures, by Space10, IKEA's design and research lab. They imagined a future home or community. For this, they used generative AI tools not just as visualizing tools but as conceptual design tools to help conceptualize spaces in a way that architects are co-designing with the AI tools. Some inputs are given by the designer that the AI tools build on, thus co-creating designs.

Similarly, an employee at DP Architects, shared some insights on the use of AI for generating interior or landscape designs. It has slowly been integrated into the day-to-day designing in pan India projects across residential, hospitality and commercial sectors. The use of AI has taken off as some companies have developed their AI-based software for architectural designs. DPA, for example, has developed its proprietary AI software that enables rapid design creation, translating mental sketches into detailed visuals with minimal inputs and prompts.

However, since construction is a task that requires precision and has an extensive impact on civil society, there is no place for errors and the tasks cannot rely exclusively on AI. Hence, while the generation of designs using AI has been a rescuer in getting through creative blocks and reducing the time used for visualizing ideas, human intelligence remains central to the creation of physical infrastructure that has to be analyzed carefully. The schematic representation, design development and execution are closely examined to minimize any errors.

She further stated that in aspects of design visualization, AI performs another important function. Finalized projects require compelling storylines for the marketing team to pitch to clients. Once the concept is already in hand, simple keyword-based prompts are fed into AI tools to finalize story decks. AI tools such as ChatGPT help in two ways, either in writing a processing quote to make images or in making the images through an already written processing quote. The director of DesignAware shared that these natural language processing tools have helped simplify the work of architects since giving complex instructions is no longer required.

## PHYSICAL INFRASTRUCTURE BUILDING

Construction of buildings and structures brings any visualized design to fruition and therefore requires increased attention of the workers and construction managers. The coordination and execution in terms of making and putting the building blocks together requires dealing with very complex geometry. AI has helped simplify this process by helping workers bridge the gap between digital design and the real-world construction of physical infrastructure.

The Director of DesignAware noted the completion of complex building processes through augmented reality tools such as Fologram used on construction sites. In complex building activities, it is not easy for the workers on site to measure each construction block or unit in the design. This is also because each unit or building block is uniquely placed in the structure. Augmented reality tools use cameras to superimpose digital designs on the site using augmented reality headsets. The tool then guides the worker in the placement of each of the blocks and in setting welding angles as well. This is an exemplification of extended reality technology blending the virtual the virtual design with the specifics of the physical world. Once the worker places the digital

design in alignment with the site, the AI tool uses color coding to signal whether the block is placed correctly or not. This is effectively like the use of butter paper for tracing which we have been doing all our lives. This helps workers carry out complex building activities with relative ease and in reduced time.

## TRANSPORT & MOBILITY

Transport and mobility perennially remain areas of importance for the Indian economy. Together, they form the linkages between other crucial sectors.[12] Easy mobility of its people and goods is therefore a concern of national importance. But it is also important for the fulfillment of people's everyday needs. This necessitates active and attentive planning of urban transportation infrastructure to reap the benefits of rapid urbanization and people's movements to the cities for the betterment of the nation.

While India has one of the most extensive transportation networks globally, it is laden with issues related to congestion, efficient traffic flow, movement of goods, etc. that act as barriers to urban mobility. Heavy reliance on pollution-intensive transport births the need to implement smart practices in their deployment. Congestion and related costs have steadily increased in the country with the cost in Delhi being estimated to reach 14,658 million dollars per year by 2030. Simultaneously, Ministry of Road Transport and Highways (MoRTH) statistics suggest that on-road accidents have also increased in numbers. Alongside these statistics, public transport development has seen minimal change. These issues are now being solved using AI.[13]

Artificial intelligence in areas of mobility and transportation has been used in assistive technologies that help in decision-making based on considerations of safe and efficient mobility in the city. It helps in controlling traffic to reduce congestion and enhancing security by managing crowds.[14] Various state governments have implemented traffic management models. In early 2024, Sikkim became the first state to introduce an AI-driven traffic management system. The standout features of this system include the ability to optimize traffic signals based on traffic densities at various junctions. It also improves regulation efficiency by automating the verification of documents and the detection of violations. It also reinforces traffic rules through automatic number plate recognition (ANPR) based tracking of defaulting vehicles. Mr. Raj Yadav, Transport Secretary of Sikkim noted that "This automated detection and enforcement have led to a significant increase in compliance with traffic laws".[15] Similarly, under its initiative of fully automating its traffic control systems, Bengaluru city has implemented an AI-driven Adaptive Traffic Control System (ATCS) at 41 junctions to end the need for manual traffic management.[16] More recently, the Transport Department of Delhi floated a tender for an Intelligent Traffic Management System (ITMS) using AI and deep learning technology and installing ANPR across 500 key junctions in Delhi.[17]

Addressing concerns on road safety, Union Minister Nitin Gadkari launched the iRASTE project on a pilot basis in Nagpur in 2021.[18] The project aimed to utilize AI for predictive analysis to prevent accidents and effect a 50% decline in the same. Accident-prone blackspots were to be identified and repaired by the ministry thus transforming road safety engineering.[19]

Similarly, concerning public transportation enhancements, the Ministry of Railways, Govt. of India decided to use AI to use non-intrusive sensors for remote monitoring condition monitoring of signals, track circuits, axle counters and their sub-systems of interlocking, power supply systems including the voltage and current levels, relays, timers.[20] Most recently, the Delhi Government joined hands with IIT-Delhi to use Big Data analysis and AI-driven solutions for the design of efficient routes for Mohalla Buses in 2024.[21] Further, these help alleviate air pollution and the consequent health issues birthed by traffic congestion.

Another struggle with transportation pertains to the achievement of demand model accuracies in preparing transportation plans that have been associated with the lack of proper structural data on the movements of people within cities every day. To tackle this issue, AI-based tools are being deployed for accurate employee estimations to help support transport models. These help analyze the sites and their vicinity to develop designs based on the demands of people in tandem with the characteristics of the locations. In terms of transportation planning, once data is read, a second use of AI is in terms of imagining, designing, and visualizing layouts. The director of DesignAware shared insights that spatial design tools that are guided by already preset spaces are used to analyze and find adaptable designs. Once computational tools have made their assessments through data on people's movements, walking areas, etc., these tools guided by preset images help visualize appropriate designs.

## SUSTAINABLE INITIATIVES

As more people settle into our cities, the cities have to be better equipped to handle increased amounts of waste and dispose of it effectively. Conventional waste disposal methods need significant use of human resources and employ strategies that lead to the wastage of fuel and resultant environmental pollution. AI-based waste management systems use intelligent equipment to encourage recycling by providing real-time feedback.[22] In 2021, the Pune Municipal Corporation planned to utilize AI in handling civic issues like garbage management. It identified 150 spots where garbage dumping was rampant to use AI to fine citizens defacing public spaces. After the identification of the spots, mitigation programs will be carried out using mechanized sweeping machines. The aim is to reduce human intervention in garbage collection and disposal.[23]

Similarly, with more people to cater to, our cities require judicious energy consumption which needs a strengthening of monitoring and regulation systems available for the

same. Smart electricity initiatives in India use AI to enhance energy management. Artificial Energy Markup Language (AIML) is used for predictive maintenance of energy infrastructure. Sensors attached to transformers and substations generate data that enables AIML models to predict failures. This technology is also used for demand prediction by reading power consumption patterns which allows for the detection of anomalies and refinement of the model.

The Smart City Mission of the Government of India has emphasized the need for sustainable initiatives in navigating the requirements of urban centers. Under this, 100 command control centers were developed including one in Pune. These centers helped in data analysis by using artificial intelligence and machine learning to model the spread of the virus and manage containment zones effectively.[24] Similarly, the initiative began with the aim to implement smart water solutions that collect real-time data from existing water networks which can be used for regulating water distribution. The Mission emphasized the use of AI, smart sensors, and technologies to improve leak detection by locating leaks and eliminating false leak alarms.[25]

In 2023, the architectural firm Design Forum International (DFI) alongside the Government of Odisha began working on the Odisha Mining Corporation - the First AI-Powered Energy Efficient Building in India located on the highway connecting Chennai to Kolkata. The project aims to make this building a dynamic structure that continually adapts to its environment. The design of the building includes the projection of AI-controlled animated patterns on the connecting bridges of the building using HD projectors.[26]

## SAFETY ASSESSMENTS

Civic safety involving measures and initiatives implemented to ensure the protection and well-being of citizens is an important determinant of the quality of life within cities. It is of utmost concern for governments and private firms to ensure the safety and well-being of people through robust infrastructure and regulations. Safety assessments in construction and urban planning span several initiatives including site monitoring and robust architecture, crime control, and disaster management.

On construction sites, AI-based solutions utilizing sensors, drones and cameras also aid the process of construction by keeping a check on the construction site at all times. These ensure the resilience of the sites as well as warn construction managers and architects of the possible hazards and resulting changes needed in the construction process. Silicon India noted that the demand for robots in the construction industry is being felt across processes such as logistics robots, autonomous drones and building automation. Further, it stated that the GOI is expected to invest over $13 billion to boost the adoption of robots in construction.[27]

The following is a case in point of the adoption of AI in site monitoring. In April, 2024, Engineers India Limited (EIL) forged a strategic partnership with Detect Technologies Private Limited to use the real-time monitoring capacity of AI to monitor project progress at construction sites and enable the use of safer construction practices. The primary objective of this partnership is to prevent accidents and injuries at construction sites that result in a loss of time and human resources. The Memorandum of Understanding states the development, operation and maintenance of an AI solution that shall utilize cameras, drones and cloud computing to make a safe environment at construction sites.[28]

Similarly, advanced surveillance and monitoring technologies such as digital twins, drones and artificial intelligence are also being used to ensure the safety and security of public physical architecture such as tunnels. These provide high-resolution data to map, monitor, and manage the condition of tunnels, identify any anomalies, and aid rescue operations. Digital twin models enable the monitoring of rock bolts, detect loose falls, and overbreak/underbreak analysis while enhancing drilling and blasting processes with precision. Aiding this, drone-based LiDAR technology, like Hovermap launched by Squadrone Infra, is used for tasks such as tunnel void detection, crack evaluation, and underground mapping. These eventually help support search-and-rescue operations in times of accidents. For example, advanced drones were deployed after the 2023 Silkyara-Barkot tunnel accident in Uttarakhand.[29]

Additionally, AI-enabled systems are allowing vehicle identification, facial recognition, number plate detection, and helmet compliance checks in tunnels to ensure greater safety by monitoring whether or not people follow all rules. In May 2024, the Jammu and Kashmir Police installed AI-based systems on the Jammu-Srinagar National Highway for this purpose.[30]

An employee at CitySabha, an organization working in research and advocacy for reimagining public spaces through conversations with diverse stakeholders, shed some light on the use of AI by independent organizations in making citizen-centric navigation tools in the city. She emphasized that while AI is in a nascent stage of development, it has been integrated into the safety assessment systems of bigger tech-driven organizations such as Safetipin. Safetipin's MySafetipin app analyzes data from various sources to compute a safety score for all locations. This helps individuals make choices for enhanced safety as they move within the cities. The Safetipin database encompasses pictures taken at predefined distances which are saved to the server. Then, machine learning (computer vision) algorithms are run on these pictures to extract information on safety parameters. These parameters include assessments of available amenities that make the spaces safer such as accessibility of bus stops, functionality of public washrooms, etc.[31]

## CRIME CONTROL

Crime rates in the cities have continually posed a challenge to public safety and mobility. Smart city endeavors have repeatedly focused on tackling crimes and other emergencies through improved city designs and surveillance mechanisms informed by data. The potential of AI to aid the making of safe cities by strengthening surveillance systems has been realized in some Indian cities. Smart command centers with sophisticated surveillance mechanisms keep check on people's movements, and crimes and enhance public security by taking real-time, data-informed measures.

For example, in 2015, Surat City Police became the first city police to get a Picture Intelligence Unit (PIU). This was part of the Safe City Project initiative in Gujarat. Within this, the Face Recognition Solution intelligently matches faces appearing on the surveillance cameras to the available database in real-time. It then generates alerts for the police to address the suspicious or criminal activity spotted within the surveillance zone. This facilitates immediate action, quick track down and reduced time wastage in investigating criminal cases. In 2015, it was noted that this intervention led to a 27% decline in the crime rate in Surat.[32]

In January 2024, Ahmedabad reportedly became the first Indian city to use AI for monitoring by municipal corporations and police. This surveillance system includes live drone footage and camera feeds from various traffic signals and buses. It is capable of analyzing traffic violations and unidentified activities. It can also locate missing people. The use of AI in this endeavor is crucial because it monitors footage in real-time.[33]

## DISASTER MANAGEMENT (Focus on floods)

Safety during times of disasters is a pressing concern requiring governments and civil societies to be prepared for action and evacuation beforehand. Our geographical specifics result in the area being prone to disasters such as floods, cyclones, and earthquakes. Floods in particular have hit the country since ancient times resulting in massive livelihood losses. In the recent past technological integration has helped in disaster management.

Predictive analysis is a function of AI-based tools that help prepare for disasters beforehand. In the recent past, Cachar was one of the most flood-affected districts in Assam. The district disaster management authority (DDMA) determined that over 85% of the total population was affected during the 2022 floods with the district recording over 45 deaths, the highest in the state. In early 2024, Assam's Cachar district administration launched an AI-powered application to combat floods by strengthening communication among citizens, response teams, and the government. The app is called Rapid Action for Humanitarian Assistance in Tragedies (RAHAT) and aims to integrate information and communication technology into risk prevention, mitigation, response,

and recovery. This is envisioned by sharing critical information for dissemination of early warning, strengthening the supply of essential items including medical aids, relief camp/center management, damage and loss assessment, prepositioning resources, etc.[34]

## CROWD MANAGEMENT

Safety becomes a vital concern in times of events seeing mega footfalls as well as in evacuating people in times of emergencies and disasters. Burgeoning crowds cannot be easily handled if the preparation for the same has not been done in advance or there is a lack of availability of real-time information about the same. AI, with its function of predictive analysis, is a major lifesaver in mitigating situations such as these. It has the potential to provide effective crowd-management solutions and has been deployed for the same in the recent past in India.

## THE KUMBH MELA EXPERIMENT

The Kumbh Mela Experiment is a case in point of the use of AI for civic safety and well-being. The Maha Kumbh Mela in Prayagraj is the largest congregation of humans which saw the coming together of over 20 crore devotees taking a dip in the confluence of the Ganga, Yamuna and Saraswati rivers in 2019. It was listed in the Guinness Book of World Records for the largest management of crowds, sanitation, and painting on public sites. Artificial intelligence was utilized for the first time in the history of the event and Larsen and Toubro took up the task of traffic and security management, crowd control and surveillance, and sanitation and waste management. They installed 1,100 cameras at 260 points across Prayagraj to monitor the aforementioned issues. These cameras had sensors that sent soft alerts when the crowd density exceeded 3 persons per square meter and a stronger one when it went beyond 5 persons or more. These signals when sent to the Integrated Command and Control Centre (ICCC), one in Kumbh and the other in Police Lines in Prayagraj gave crucial information like traffic violations, number plates, and face recognition to monitor people.[35]

Regarding waste management, it has been recorded that the generated solid waste channeled through 500 dustbins and 48 dumping locations tracked via GPS. Further, an AI-based Solid Waste Management System was used to find routes for waste collection vehicles based on bin sensor data and traffic data.[36]

Uttar Pradesh Chief Minister Yogi Adityanath has directed the state police to prepare for the upcoming Kumbh Mela, 2025 mentioning that the scale of this mega event is expected to be unprecedented (expanding from a 3200 hectares area in 2019 to 4000 hectares in 2025). This necessitates the setting of a benchmark in terms of security and convenience in Prayagraj, using artificial intelligence for effective crown management and averting any untoward incident.[37] For this, the installation of 2,300 CCTV cameras connected to the ICCC is in progress. These cameras will send information related to

crowd densities to the ICCC, suggesting alternative routes to regulate crowds or allow the immediate deployment of security forces in places where the crowd density goes out of hand.[38]

## CHALLENGES OF AI ADOPTION IN CONSTRUCTION AND URBAN PLANNING

The introduction of AI to urban planning and construction highlights its potential to aid governance and public service delivery providing solutions to urban infrastructural and societal challenges. It provides for the making and maintenance of safe, sustainable and resilient cities. However, its adoption is also laden with challenges that include:

AI-driven mobility and safety solutions utilize data collected from cameras installed on city streets. This implies that for these solutions to work, civil society is under constant surveillance. This births the challenge of interference with people's privacy in the use of images or information without permission and the ethical concerns associated with the same. UN Habitat's Global Assessment of Responsible AI in Cities stated that 53% of the respondents expressed worries about the safety of personal data. The Director of DesignAware informed that alongside privacy concerns and also the questions of authorship and ownership of data and designs. She raised the difficulty of determining ownership; Does the one who computes a database own or the people who contribute to it? Currently, there is little to no transparency of the sources of datasets. Branching from this is also the challenge of laying down legal and regulatory frameworks as reported by 52% of the respondents.[39] In light of this, an employee of CitySabha emphasized the increased requirement of regulations and guidelines to use AI with a citizen-centric approach.

Both the Director of DesignAware and the employee of DP Architects addressed the biases in AI-based solutions for construction and design. AI tools are fed in data about satisfying market demands. While this is important, over time it leads to the formation of biases in design, thereby reducing the variety in the generation of designs. This is a greater concern in a country as diverse as India which requires a very diverse database to design physical infrastructure. Beginning from the interior requirements to the master plan, Delhi has very different requirements than Mumbai. Similarly, the heterogeneity can also be noted in the scales and densities of movement of pedestrians or public transport networks which will vary in Kerala and Pondicherry. However, biases in the design have meant that the idea of India or an Indian street as visualized by AI tools is very dated. There needs to be diversity to cater to India.

Elsewhere, introducing AI in combination with other technologies like IoT or Blockchain births two major issues. The first is the interoperability issue or data integration across technologies for which we're not entirely equipped. The second issue relates to the infrastructural lags resulting from the vulnerability of some demographic sections.

Lack of internet connections or interne-compatible devices pose the problem of accessibility to AI and awareness of the same. In the same research, 45% raised the knowledge of the extent of AI's potential as another significant concern.[40] An employee from DP Architects also noted the accessibility issues in terms of knowing about a tool and having organizational investment, which is one of the reasons for the limited use of AI in urban planning and construction. The Director of DesignAware advocated the open-source access to AI tools in governance and civic development to create a decentralized system.

Other challenges reported relate to the utility of the technology. 58% of respondents reported that the cost of implementation is a serious concern associated with using AI in cities. Model maintenance is a process that has to take place frequently resulting in rising costs.[41]

## FUTURE OUTLOOK

India's transition from a predominantly agricultural economy to one now focused on services transform the landscape of workforce skill development into an imperative. In 2022, 83% of industries in India reported talent shortages,[42] with the construction industry having the highest shortage of skilled labor at 85%. An employee at DP Architects noted that not many people are acquainted with BIM within the construction industry, and not everyone has been upskilled to utilize it. AI, introduced much later, has a long way to go before everyone can understand, access, and use it.

Simultaneously, however, as the Director of DesignAware informed, contrary to the belief that AI will kill jobs, AI has created jobs opening opportunities for engineers and coders while being used to support human intelligence and not replace it. India, therefore reliant as much on its human resources as technology, is positioned to harness the potential of AI in the realm of upskilling now more than ever. Collaborative efforts in this process including the democratization of learning, and feedback mechanisms can help organizations solve access issues, contributing to the collective pursuit of excellence. AI provides a remarkable potential for expansion in this dimension.[43]

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