REVIEW ARTICLE

Asian Research Association

ASIAN JOURNAL OF INTERDISCIPLINARY RESEARCH

DOI: 10.54392/ajir2522

Adoption of Digitalization and Sustainable Services for Legal Practice 4.0: A Comprehensive Review

Saurabh Singh [a], Rajesh Singh [b], Anita Gehlot [b], Shaik Vaseem Akram [c], Amit Kumar Thakur [d, *], Sudhanshu Dogra [d]

[a] Uttaranchal Institute of Technology, Uttaranchal University, Dehradun 248007, India.
[b] Division of Innovation and Research, Uttaranchal Institute of Technology, Uttaranchal University, Dehradun 248007, India
[c] Department of ECE, School of Engineering, SR University, Warangal, 506371, Telangana, India.
[d] School of Mechanical Engineering, Lovely Professional University, Phagwara, Jalandhar, Punjab, 144001, India
* Corresponding author Email: amitthakur3177@gmail.com

DOI: https://doi.org/10.54392/ajir2522
Received: 24-01-2025; Revised: 12-04-2025; Accepted: 23-04-2025; Published: 30-04-2025

Abstract: Currently, the world is collaborating toward sustainable development goals (SDGs) in an attempt to offer people a sustainable ecosystem. Modern digital technologies have adverse impact on lawyers' ability to improve their skills through the use of computer intelligence and real-time facts. It is also identified from the previous studies, that there are limited studies that focused on addressing the sustainability of legal practices with the integration of Industry 4.0 technologies. This study explores the transformative potential of Industry 4.0 technologies in modernizing legal practices toward sustainability. While prior research has focused on digital innovation in various sectors, inadequate attention was drawn towards the systematic presentation of technologies like artificial intelligence (AI), blockchain, digital twins, and augmented reality in legal environments. Addressing this gap, our structured literature review synthesizes recent advances and maps specific use cases such as e-discovery, automated contract generation, evidence authentication, and digital courtrooms. We also examine the challenges associated with these transformations, including data privacy, job displacement, and ethical risks. The study proposes an AI-based architecture and highlights real-world legal tech applications. By aligning digital transformation with Sustainable Development Goals, particularly Peace, Justice, and Strong Institutions which is Goal-16, this article seeks actionable recommendations for law firms, educators, and policymakers to adopt Legal Practice 4.0 responsibly and effectively.

Keywords: Digitalization, E-discovery, Legal analytics, Legal practice, Smart cities, Sustainability

1. Introduction

Digital transformation is reshaping every professional domain, including the traditionally conservative field of legal services. In alignment with the United Nations' Sustainable Development Goals (SDGs) notably Goal 5 (Gender Equality), Goal 7 (Affordable and Clean Energy), and Goal 16 (Peace, Justice, and Strong Institutions) legal practices are increasingly adopting technologies to offer smart, inclusive, and accessible services (Plasschaert *et al.,* 2020) [1]. The rise of Legal Practice 4.0 refers to the integration of Industry 4.0 technologies such as AI, IoT, blockchain, and big data into the legal domain, promoting efficiency, transparency, and sustainability (Basoeky *et al.,* 2021). The legal profession is greatly impacted by advancements in information and communication technology. It has an impact on the legal services provided by attorneys who prepare for change brought about by globalization or advancements in information technology (Endarto *et al.,* 2019). Technology advancements will have a positive impact on the legal services sector. Innovative law firms will be able to offer legal counsel that is less expensive, quicker, and more precise. Human legislators, judges, and attorneys will face numerous difficulties as a result of these changes (Alarie *et al.,* 2016). Digital technologies can never eliminate the distinct capabilities which humans possess to deal with law's complex details and produce fresh innovative solutions. Law professionals should embrace digitalization as a valuable enhancement of their skills instead of viewing it as a threat to their profession because it supports better work effectiveness. Expertise for lawyers includes both formal substantive education received during law school and a foundation of cumulative experience earned in practice. In fields, like medicine, minimal education

constantly includes clinical or apprenticeship training methods (Gruner, 1986). Lawyers all across the world are starting to analyze contracts, research case law, and forecast judicial decisions using statistics, machine learning, and data science (Alschner, 2021). A growing number of websites are introducing users to lawyers and offering cutting-edge legal services. It is necessary to make the deontological convictions of lawyers, who supply legal services as well as participate in the administration of justice, consistent with this direction.

Deloitte discovered in early 2016 that 39% of legal jobs would be automated within the next ten years. McKinsey's research indicated that automation could replace 22% of legal work performed by lawyers as well as 35% of work done by law clerks. Thomson Reuters and consultant Adam Smith projected that United States spending on alternative legal service providers (mainly suppliers of AI-based solutions) would reach $85 billion by 2027 after starting from $12 billion in 2017 (Davis, 2020). The justice management system represents one component of society which technological progress has influenced throughout the world. Legal services from the court need to run electronically through an application named e-Court (Viana, 2019) and using smart contracts, a type of computer program that can run automatically without the parties' active involvement (Pratiwi *et al.,* 2020) [9]. Despite technological evolution across sectors like banking and manufacturing, the legal field has seen limited structured reviews addressing how digital innovations affect legal processes, legal education, and law firm operations. This study aims to fill that gap by answering: What is the current state of digitalization in legal practice? What technologies are most impactful? What are the implementation challenges and future directions?

Our contributions are threefold:

- We map Industry 4.0 technologies to specific legal applications such as digital case management, contract automation, and virtual courtrooms.
- We propose a modular AI-based architecture for legal practices and identify practical implementations and limitations.
- We offer policy and pedagogical recommendations for adopting digital solutions sustainably.

This paper is organized as follows: Section 2 elaborates on the need for digital transformation in legal practices. Section 3 reviews enabling technologies and their direct impact on legal functions. Section 4 outlines the proposed AI-based architecture and blockchain integration. Section 5 presents implementation challenges and recommendations. Section 6 concludes with a summary and future outlook.

2. Need for Digitalization in the Legal Practices

Legal systems face several systemic inefficiencies—case backlog, physical documentation, energy usage, and lack of transparency. Case delays are often caused by the slow transfer of records, untraceable affidavits, and missing documentation (Forell & McDonald, 2015). The different cases will be exposed to the different laws available (figure 1). In every case, they will be the utilization of a multitude of laws. Cases have also been adjourned merely because affidavits filed several years ago were not restored with the record or could not be traced. Digital tools such as e-Courts, online arbitration platforms, and legal databases can significantly reduce delays while enhancing service delivery which results in saving tremendous amount of energy and reducing waste of paper (Cui & Zhang, 2021). Law practice necessitates modern adjustments because experts need to build sustainable delivery systems which handle clients' requirements while building a better sustainable future. Sustainable development initiatives have become essential to firm reputation according to market feedback and client expectations.

Leading firms like LegalZoom and LegalShield now offer online services including document automation and e-discovery (Hongdao *et al.,* 2019). Internationally, Freshfields Bruckhaus Deringer has developed the "Antitrust 101" app to support compliance. These examples show that digital technologies can reduce costs, boost efficiency, and improve access to justice. In the view of artificial intelligence (AI), the AI assists the lawyer in implementing cognitive analytics to empathize with the client regarding the upcoming judgment of the case. The motive behind applying AI in legal practices is to assist the lawyers but not the replacement of the lawyers. Moreover, the national law review concluded that augmented reality and virtual reality can be utilized by lawyers to recreate the cases and practices in the courtroom and also assist the lawyers in more closely evaluating the witness and jury reaction with the most recent concrete information. In recent studies, Taylor University encouraged first-year law students to learn

law using AR and neuro-linguistic programming (NLP) techniques to enhance the graduates (Amirnuddin & Turner 2022). Blockchain technology in legal practices encourages real-time tracking the custodian documents and case documents with hash algorithm encryption (Schlarb *et al.,* 2019). The blockchain assists in realizing tokenization, automated regulatory compliance, arbitration system, LAO, and machine-to-machine payments. Blockchain empowers us to connect and share files in a distributed network with high security. Figure 1 breaks law into two main sections that are International and National. National law consists of two main branches which are Substantive (Public and Private) law and Procedural law that establish different jurisdictional areas including criminal law and constitutional law together with employment law and family law.

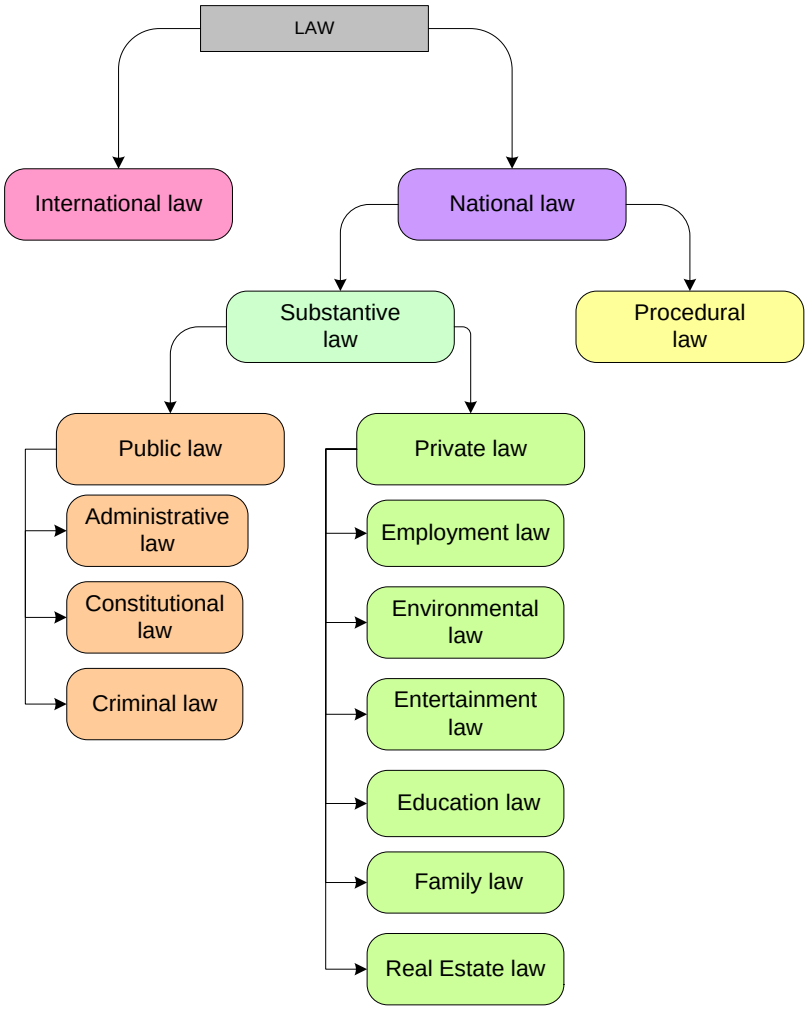

Figure 1. Classification of Law

Figure 2 provides a conceptual overview of how digitalization is reshaping legal practices through three transformative technological pillars Artificial Intelligence & Natural Language Processing, Blockchain Technology, and Augmented/Virtual Reality. Each pillar highlights specific legal functions enhanced by technology:

- AI and NLP enable e-discovery, contract analysis, cognitive review, and virtual legal assistants, helping law firms improve accuracy, reduce manual workload, and enhance client services.
- Blockchain supports secure document custody, smart contract execution, regulatory compliance, and the creation of autonomous legal organizations—ensuring transparency, immutability, and trust.

AR/VR allows immersive experiences like virtual crime scene reconstruction and courtroom simulations, enriching legal education and client interaction.

This figure encapsulates the core idea of Legal Practice 4.0 a digitally empowered legal ecosystem that integrates innovation into case handling, client management, and legal education, supporting the broader goals of sustainability, accessibility, and efficiency.

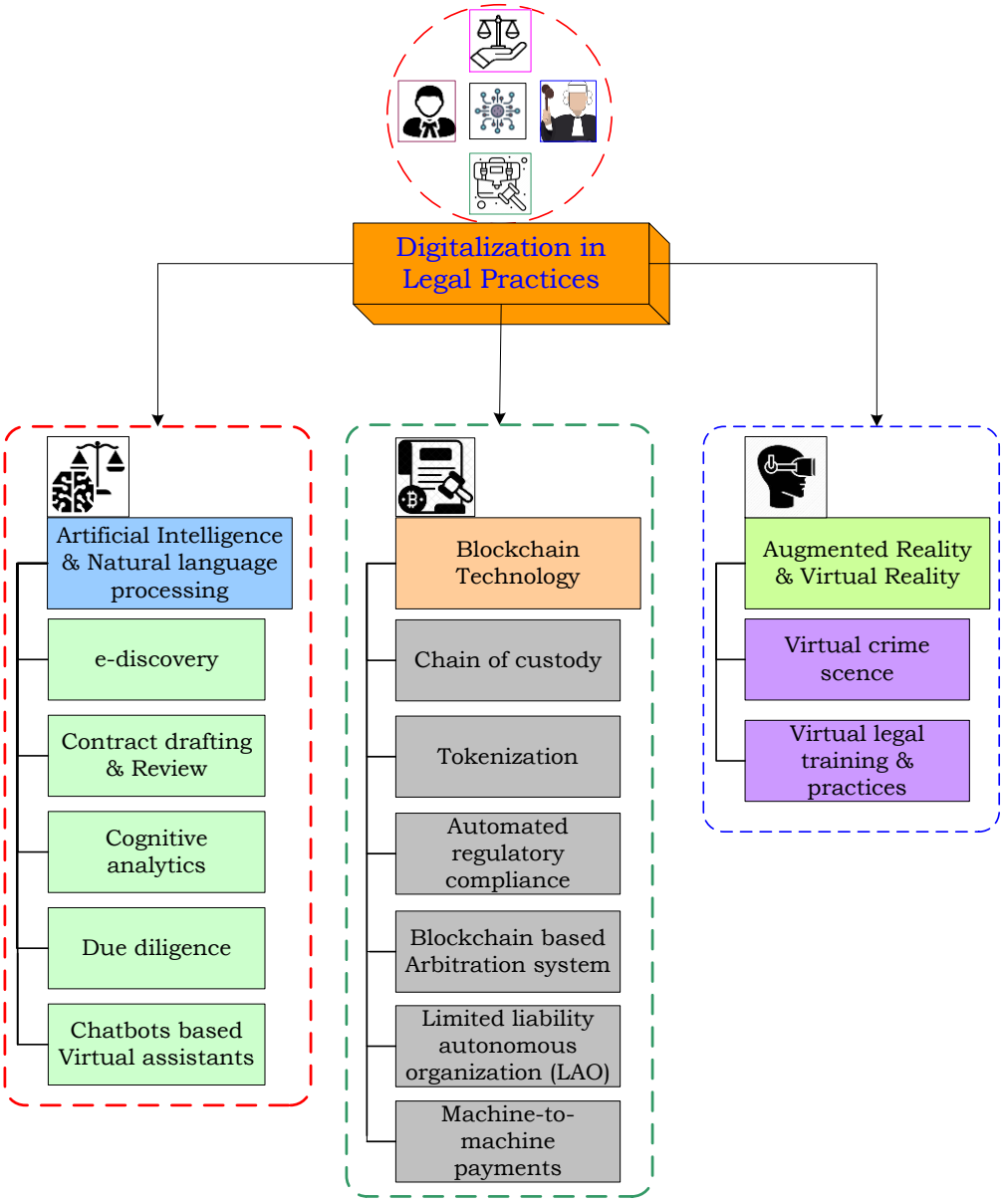

Figure 2. Digitalization in Legal Practices

3. Technologies Transforming Legal Practice

Each technology discussed below includes a brief on its functionality and its relevance to legal practices. AI, Bigdata, blockchain, ML, AR/VR, and NLP are the technologies that have been discussed below.

3.1 Internet of Things

IoT devices, such as smart lockers and biometric entry systems, can streamline courtroom logistics. Voice-based appointment systems and emotion-sensing client assessment tools are emerging applications. According to the GSMA forecast IoT will have 25 billion connections worldwide by 2025 (GSMA, 2020) IoT functions as a network of devices with integrated systems that operate through the Internet telecommunications system and transfer data automatically (Souri *et al.*, 2022). Under the scope of IoT exist Machine-To-Machine (M2M) networks which permit intelligent devices to exchange information while independently acting upon their received and produced data.

3.2 Artificial Intelligence (AI)

AI is widely used in predictive legal analytics, document review, and risk assessment. Platforms like Lexis Analytics utilize NLP and ML to forecast case outcomes, classify legal documents, and assist in contract analysis. AI also powers chatbots for legal consultation, virtual assistants for lawyers, and automated compliance tools [18] (Jefferson, 2017). Technology-assisted review (TAR) with modern techniques uses machine learning for document classification, often known as 'predictive coding in the legal field (Chhatwal *et al.,* 2017). Machine learning (ML) is concerned with developing computers that learn automatically from experience. Today this technological field demonstrates the fastest expansion rates since it links data science with artificial intelligence while resting between statistics and computer science.

3.3 Edge computing

Edge computing supports low-latency processing of legal data, enabling real-time analytics at court premises or legal offices. AI-enabled edge devices can deliver faster legal research results and decision support in remote or mobile setups. Various computing paradigms including Edge computing and cloud computing together with mobile ad hoc cloud (MAC) serve different application requirements in IoT environments (Filho *et al.,* 2022). Edge computing functions as a decentralized platform that enables IoT devices to leverage cloud computing functionalities through the network edge locations.

3.4 Big Data

Big Data platforms aggregate court judgments, statutes, and case law to support intelligent legal reasoning and trend analysis. They enable lawyers to detect doctrinal inconsistencies and offer better client advisories. Big Data is a term that has been used to describe the enormous volumes of data that traditional data management techniques and processes cannot handle (Memon *et al.,* 2017).

3.5 Blockchain

Blockchain enables secure, immutable documentation. In law, it supports smart contracts, tokenization of case files, evidence integrity, and real-time custody tracking. For example, blockchain can authenticate timestamps on digital evidence, automate arbitration clauses, and ensure transparency in property transactions. Blockchain technology has slowly evolved. Healthcare, business, banking, and the auto industry are all increasingly embracing blockchain technology (Chen *et al.,* 2024). Blockchain is a next-generation information technology development for accomplishing sustainability in businesses and industries (Leng *et al.,* 2020a). The adoption of blockchain applications in various fields continues to face challenges such as flexibility, scalability, and cybersecurity. A recent study looked at methods for tackling potential cybersecurity barriers in accomplishing intelligence in Industry 4.0 (Leng *et al.,* 2020b). In addition to this research, a method (Makerchain) is being implemented with a chemical signature based on blockchain to enhance the handling of cyber-credit in the manufacturing process and to portray distinctive characteristics of products (Leng *et al.,* 2019). During the Industry 5.0 transition researchers developed a prototype that enables blockchain smart contract and pyramid-driven multi-agent autonomous process control for manufacturing peer-to-peer coordination (Leng *et al.,* 2023). Blockchained smart contracts are used to decentralize customized task execution among machines and make the outcomes accessible on a cloud-based topmost deep learning model for assisting comprehensive rescheduling judgments (Leng *et al.,* 2022a).

3.6 Augmented Reality (AR) / Virtual Reality (VR)

AR/VR technologies allow for crime scene reconstructions, virtual depositions, and courtroom visualization. Taylor University, for instance, integrates AR into its curriculum for experiential learning, which helps in extracting sensible and accessible insight that can be used in real-world applications (Han *et al.,* 2022). The computer-generated virtual reality presents real-looking scenes alongside objects which create a fully immersive experience for viewers. The virtual environment becomes perceivable through wearing a Virtual Reality headset or helmet according to (Ludlow, 2015). Users experience video games through VR technology which makes them feel they are playing as a

character along with gaining essential skills like heart surgery and enhancing athletic training standards. The implementation of AR/VR is realized with the integration of a multitude of sensors such as light detection and ranging (LiDAR), thermal sensors, rear-facing video cameras, ambient light sensors, and structured light sensors.

3.7 Digital Twins

The production of digital representations for physical objects and assemblies through integrated simulations combined with service data makes up a digital twin (Zheng *et al.,* 2019). Various product life cycle data forms the basis for the digital representation. Decision-making receives improvement through data that continuously updates and visualizes across different formats to predict present and future operational conditions in design and operational spaces (Fuller *et al.,* 2020). Digital twins build accurate digital versions of courtrooms which serve for teaching operations alongside case simulation. Both virtual hearings and lawyer-client interactions happen through 3D environments in the metaverse setting. Immersive educational tools in legal instruction and virtual services bolster education standards and guarantee universal service availability. A digital twin approach with the FSBCIP framework lets users learn how to design smart manufacturing systems through its control and intelligence models to spot structural and functional design faults in advance (Leng *et al.,* 2021a).

The future digital twin-based configuration system will enable semi-physical simulations for system performance testing throughout the configuration and reconfiguration period. The smartphone assembly line utilization of digital twins for remote semi-physical commissioning served as the basis for implementing DT-RSPC to facilitate remote semi-physical commissioning (Leng *et al.,* 2021b). A digital twin-based methodology uses optimization results to validate semi-physical simulation according to the researchers (Leng *et al.,* 2020c). A new digital twin-based warehouse optimization strategy develops an integrated approach for warehouse product-service system storage and stacking assignment (Leng *et al.,* 2021c). The investigators propose an ensemble algorithm with the three-layer Learning-imitation-acting approach for OAPL open architecture production lines utilizing system reconfigurability and digital twins system (Leng *et al.,* 2022b).

3.8 Metaverse

METAVERSE, a combination of the prefix meta (inferring transcending) with the word universe, illustrates a hypothetical synthetic environment associated with the physical world (Garavand & Aslani, 2022). A Metaverse functions as a digital space combining physical elements and virtual components delivered through Internet and Web systems and Extended Reality (XR). Metaverse contains characteristics that distinguish it as the next generation of the Internet. Users' genuine presence is related to this technology's three-dimensional space, and the potential for interaction and cooperation in its environment is supplied. The equipment and features are built to a standard so that different Metaverses can interact with one another.

4. Intervention of technology in Legal Practices

In this section, we have discussed the intervention of digital technologies such as AI and blockchain in legal practices. Initially, AI in legal practice with architecture and blockchain in legal practices are discussed.

4.1 Legal Practice & Artificial Intelligence

Though currently challenging to implement, AI technologies provide new avenues of automation fit for distinctive and largely unstructured legal services (Khabibullina *et al.,* 2019). AI and law refer to the application of AI to the enforcement of laws. To estimate a defendant's likelihood of reoffending, judges are increasingly adopting computing tools that use AI (Repina *et al.,* 2019). Efficiency-boosting capabilities are a well-known benefit of adopting AI tools in legal practice. The demand for law companies that use AI will increase, while firms that are unable to automate their processes risk losing clients as a result of charging more for the same services (Surden, 2018). Advanced modeling, text mining, machine learning, natural language processing, and other AI techniques are used to analyze text and other unstructured data, such as court decisions, perform computations, and produce advanced analytics in the field of legal analytics (Frolova & Ermakova 2021). With the help of semantic analysis and legal data

collection, AI can forecast legal outcomes. The judicial system will become more automated and effective as a result (Amariles *et al.,* 2021). The quality of legal processes will improve with the use of scientific and methodical techniques in digital courtrooms based on Big Data, blockchain, and AI (Amariles *et al.,* 2021).

Since manual paper-based filing is no longer used, traditional law offices and court administration registries can remodel their workspaces through the management and processing of legal documents in digital format (Rusakova & Inshakova, *et al.,* 2021). An "electronic person" or "electronic legal entity," which has its distinct legal personality, can be created by the legal idea of AI technology by combining multiple legal entities (Kamyshanskiy *et al.,* 2021). The development of LawTech online services aims to bring technology solutions and law to businesses, industries, and individuals while also improving and automating the management of their legal data and legal processes through IoT and AI.

Data-driven machine experience underpins machine learning (ML), which is the current wave of AI. The resulting artificial legal intelligence (ALI) may be much more adept at foretelling the details of positive law [45] (Parkhomenko, 2019). For those in the legal services industry, it would be beneficial to create and put into practice a way for structuring and analyzing legal data models based on ML (Barnett & Treleaven, 2018). The actual benefits of AI tools in the legal sector might only become clear if lawyers completely reinvent how legal services are delivered. Because ML-based techniques like natural language processing (NLP) make e-discovery possible, they are already revolutionizing many activities and eliminating the need for time-consuming processes (Hildebrandt, 2018; Metsker *et al.,* 2021). For those who cannot easily afford legal representation, ML and NLP can be used to do legal research, discover doctrinal biases and disparities, and improve the performance of lawyers and judges (Brooks *et al.,* 2020). Bots are conversational web programs that can engage with users to do specific tasks or to offer tailored advice based on the circumstances of the recipient. According to their clients' situations and facts, many law firms are developing bots to help existing or potential clients deal with legal challenges (Stern, 2018).

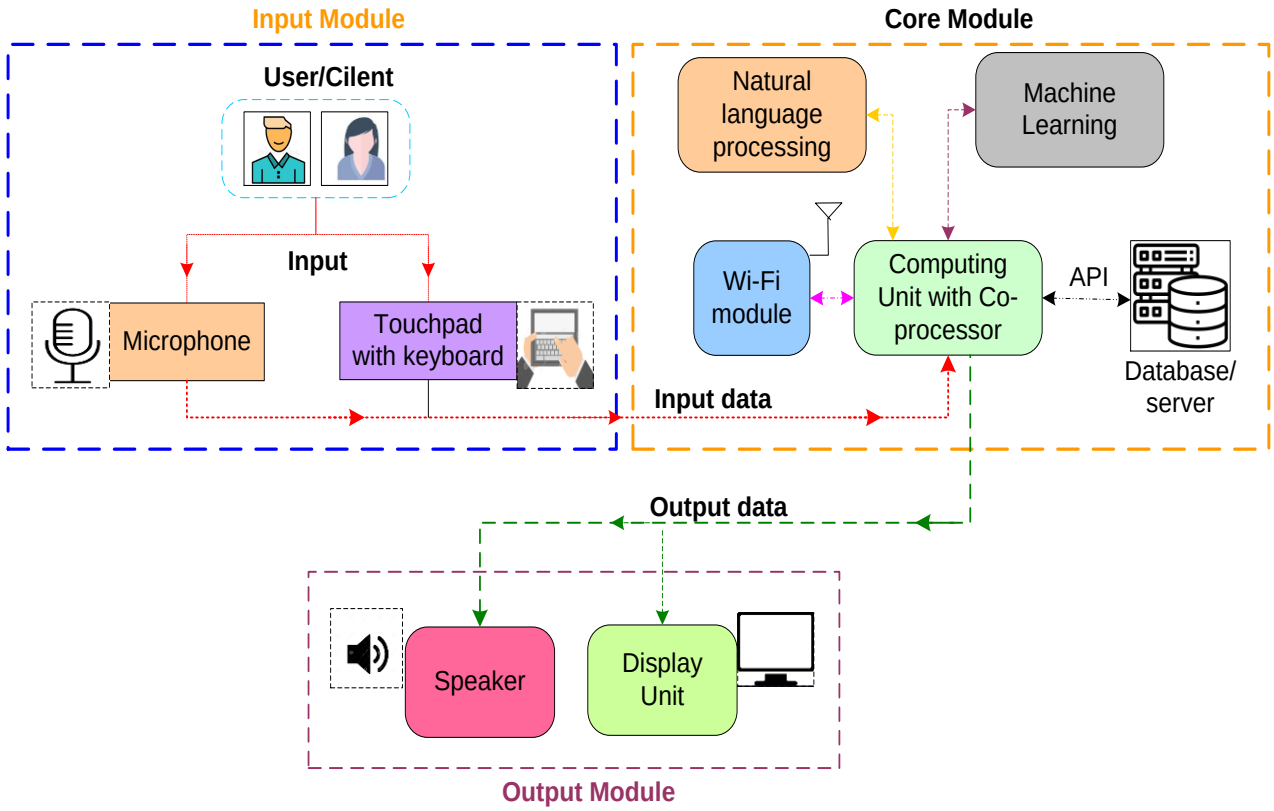

Figure 3. Generalized Architecture of AI in Legal Practices with hardware integration for e-discovery, chatbot

AI and Blockchain Architecture for Legal Practice Figure 3 outlines a generalized AI-based architecture. The system integrates voice/text-based input with NLP engines, a computing unit trained on legal datasets, and secure output modules. Responses are stored and verified using blockchain for integrity. The inclusion of 5G networks ensures real-time, low-latency interactions.

This architecture supports chatbot-based legal assistants, automated compliance reporting, and personalized client portals. Such integration demands collaboration among IT experts, legal professionals, and policymakers.

To implement an AI-based chatbot and automated system, there is a need for a communication protocol that has the capability of low latency. In legal practices, it is significant to implement low-latency communication for an effective and quick decision on the query. Currently, 5G networks are widely used for low latency, maximum reliability, and application-driven requirements. Recent research has developed a platform for assessing multiple 5G standalone time division duplex patterns in event-driven scenarios (Bektas *et al.,* 2021). A private fifth-generation (5G) network is implemented for providing the 5G services as a local area network in the fields of industry, business, and the public sector to accelerate the implementation of Industry 4.0 (Wen *et al.,* 2021). 5G campus networks are envisaged to empower revolutionary applications including robot control that necessitate cyclic delay-sensitive industrial connectivity (Rischke *et al.,* 2021). A study used an approach to create the potential for indoor connectivity on a university campus, as well as alternative value network configurations (VNCs) defining various local network deployment options (Kulkarni *et al.,* 2021). The rapid evolution of mobile communication services and the anticipation of traffic service usage of 5G data through sensitivity analysis (Shin *et al.,* 2020).

Following this issue, a study assessed 5G infrastructure strategies concerning mobile traffic growth to evaluate the unpredictability attributed to future trends and supply through hypothetical mobile network operations (Oughton *et al.,* 2018). Various autonomous systems (ASs) exchange networking data using transit networks with additional peerings at private network interconnects (PNIs) as well as public Internet Exchange Points (IXPs). Administrators must accurately predict 5G interdomain traffic volumes because these assess the needs of Internet Exchange Points that lead traffic peaks (Hoeschele *et al.,* 2021). A detailed techno-economic platform capable of evaluating not just the techno-economic framework as well as the financial feasibility of a HetNet deployment, and it is implemented in a study case of a backhaul-based transport segment (Yaghoubi *et al.,* 2018).

4.2 Legal Practice & Blockchain Technology

The regulatory environment for digital technology is evolving. The part that blockchain technology will play in creating the legal frameworks that will ensure that society and the digital world interact (Hegadekatti *et al.,* 2017). As the IoT becomes a reality owing to Blockchain technology, law firms will see a significant portion of work, such as drafting, petition appeals, etc., automated. As Smart Contracts operate on the Blockchain, contract execution will be impartial and easier to carry out (An *et al.,* 2019). The administration of public services and the strength of judicial institutions will both benefit from blockchain technology. It has been labeled as an enormous success to use distributed ledger technology (DLT) (Wilhelm, *et al.,* 2019). Blockchain and new data logging and storage technologies promise cost-effective property rights administration and backup of ancillary data (Amelia *et al.,* 2022). The legal services sector is about to undergo a period of significant innovation due to new legal technologies (LawTech), including blockchain, AI, and IoT. Equipping legal firms, with electronic discovery, document storage, practice management, billing, and accounting (Fries *et al.,* 2016). LawTech online services aim to bring technology solutions and law to businesses, industries, and individuals while also improving and automating the management of their legal processes and legal data through IoT and AI (Agrawal *et al.,* 2022).

5. Challenges and Recommendations

Law is a dynamic subject in which people aspire to practice the law as their profession, which gives rise to the concept of Legal Practices. Currently, many individuals prefer to do independent legal practices, where they have expertise in one particular field and provide exceptional services to their clients. Whether it is dependent or independent legal practices, modern digital technologies have a substantial impact on lawyers' ability to enhance their skills with computer intelligence and real-time data. Based on this, this study discussed the overview of different technologies as well as the significance of implementing these technologies by law firms and law colleges for delivering digital training and services to users/clients. However, for better usage of digital technology, a few advancements, and technological integration are essential in legal practices.

5.1 Challenges

a) **Data Privacy**: AI systems handling client data must comply with GDPR and legal confidentiality norms.

b) **Bias in Algorithms**: Pretrained models may inherit social or legal biases, affecting fairness.

c) **Job Displacement**: Routine tasks may become automated, requiring reskilling of legal staff.

d) **Adoption Cost**: Small firms may face financial barriers in adopting digital infrastructure.

5.2 Recommendations

a) Establish national digital justice policies including training and funding.

b) Integrate LawTech modules in law school curricula.

c) Promote open-source legal AI tools for widespread adoption.

d) Encourage pilot projects in digital courts and blockchain-based notaries.

In the above study, it is identified that the IoT device's implementation in legal practices is not explored. Implementation of IoT devices is highly advisable for legal practices (Mohammed & Esmail, 2015). AR/VR must be widely adopted in legal practices, as it enables taking law practitioner/client by virtual hand through a crime scene, in real-time or recorded (Xiong *et al.,* 2021). A hybrid AI model with hardware integration must be constructed and developed for a practitioner to research various genres of cases to get expertise in decision-making and strategy planning. Edge computing/fog computing are two emerging technologies that can perform data processing, data filtering, and legal analytics at the edge network itself (Deng *et al.,* 2020). Digital twins and multiverse in legal practices empower to implement the creation of a virtual courtroom, judge, and lawyers (Semeraro *et al.,* 2021). A smart court's connected sensors can collect data in real-time. This information is used to generate a map on the virtual model, resulting in the creation of a Digital Twin of a courtroom. The individual who is practicing the law can utilize this courtroom to experience the environment and gain the knowledge for decision-making of different cases that are attached to emotional and intelligent arguments. In legal practices, the number of documents for each case/client is large. The identification and protection of these documents is a highly crucial task in legal practices. The integration of IoT and blockchain in legal practices boosts the identification and protection of documents smartly and digitally (Panarello *et al.,* 2018; Shammar *et al.,* 2021).

6. Conclusion

Digitalization is reshaping legal services through AI, blockchain, IoT, and immersive technologies. By addressing systemic inefficiencies and aligning with SDGs, Legal Practice 4.0 presents a sustainable, equitable legal ecosystem. While challenges like bias, data privacy, and resource constraints persist, strategic investments and interdisciplinary collaborations can help realize this vision. This study examined the impact of these technologies on legal practices to improve their learning and depth of knowledge of the law. The study also discussed the limitations of current digitalization in legal practices and further suggested recommendations for future enhancement such as AR/VR, digital twin, and metaverse implementation for virtual imagination of courtrooms and crime scenes. The implementation of blockchain and IoT is the automation and security enhancement of the documents.

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Author Contribution Statement

Saurabh Singh: Conceptualization, methodology, validation, formal analysis, data Curation, writing-original draft preparation. Rajesh Singh: Conceptualization, methodology, validation, formal analysis, data Curation, writing-original draft preparation. Anita Gehlot: Conceptualization, methodology, validation, formal analysis, data Curation, writing-original draft preparation. Shaik Vaseem Akram: Investigation

resources, writing-original draft preparation, writing-review and editing, visualization, supervision. Amit Kumar Thakur: Investigation resources, writing-original draft preparation, writing-review and editing, visualization, supervision. Sudhanshu Dogra: Investigation resources, writing-original draft preparation, writing-review and editing, visualization, supervision. All authors have read and approved the final version of the manuscript.

Does this article screen for similarity?

Yes

Conflict of Interest

The authors have no conflicts of interest to declare. There is also no financial interest to report. The author certifies that the submission is original work and is not under review at any other publication.

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Cite this Article

Saurabh Singh, Rajesh Singh, Anita Gehlot, Shaik Vaseem Akram, Amit Kumar Thakur, Sudhanshu Dogra, Adoption of Digitalization and Sustainable Services for Legal Practice 4.0: A Comprehensive Review, Asian Journal of Interdisciplinary Research, 8(2), (2025) 21-34.
https://doi.org/10.54392/ajir2522