



Artificial Intelligence(AI) In Patent Examination: Enhancing Or Undermining The System

¹Haritha R, ²Jagadeeshwari V Gogga, ³H R Sankhya, ⁴K Prakruthi, ⁵Shruthi M N

¹Student, ² Student, ³ Student, ⁴ Student, ⁵ Professor

¹Computer Science Engineering, ²Computer Science Engineering, ³Computer Science Engineering,

⁴Computer Science Engineering, ⁵Industrial Engineering and Management,

¹RV College of Engineering, ²RV College of Engineering,

³RV College of Engineering, ⁴RV College of Engineering,

⁵RV College of Engineering, Bengaluru, India

Abstract: Artificial Intelligence (AI) is rapidly transforming patent examination with more efficiency, accuracy, and consistency through tools such as Natural Language Processing (NLP), Machine Learning (ML), and Large Language Models (LLMs) for prior art searching. While these advancements promise significant benefits for innovators by streamlining the protection of their intellectual property, their implementation also introduces major challenges such as algorithmic bias, interpretability (the "black box" issue), and complexities in legal adaptability. This review consolidates evidence from international patent office strategies, case studies, technical assessments, and policy reviews to critically evaluate whether AI considerably reinforces the patent system or adds systemic risks that can jeopardize its fundamental principles. While AI has tremendous potential to minimize human error, automate workflows, and tackle rising application volumes, its responsible implementation requires strong human intervention, the development of comprehensive ethical guidelines, and active patent law modernization to address AI-generated inventions and accountability, ensuring the patent system continues to reward and protect innovation.

Keywords - Artificial Intelligence, Patent Examination, Intellectual Property, Property Rights, Algorithmic Bias, Legal Modernization, Human-AI Collaboration, Transparency

I. INTRODUCTION

The global intellectual property (IP) system, particularly in terms of patent examination, is now at crossroads. It is faced with unprecedented pressure from the continuously increasing volume of filings and the increasing technical complexity of inventions, above all in rapidly emerging technologies like the Internet of Things (IoT) and artificial intelligence (AI) in itself. This increasing pressure calls for a reexamination of conventional evaluation practices as well as an adoption of new technological innovations.

A. Global Pressures and Traditional Inefficiencies

The sheer number of patent filings highlights the staggering workload confronting patent offices worldwide. The number of Patent Cooperation Treaty (PCT) filings in 2024 reached 273,900, a 0.5% increase from 2023, with China leading the way with 70,160 filings [1]. On a global scale, world-wide patent applications reached a record 3.55 million in 2023, up a 2.7% increase from 2022, boosted primarily by massive increases in filings from China, South Korea, the United States, Japan, and India [3]. This consistent pattern of application increases, coupled with the sophisticated nature of modern technology, generates immense pressure on existing examination procedures.

Traditional patent examination, which relies so heavily on exhaustive manual prior art searching and individual subjective interpretations of claims, is poorly suited to handle this growing workload. Examiners are likely to spend significant time on these time-consuming activities. In a 2018 Japan Patent Office (JPO) study, it is estimated that its examiners spent 30% of their time conducting prior art searching and an additional 10% understanding it [4]. The European Patent Office (EPO) has also described the astronomical number of these searches, noting that an exhaustive patent application search can involve the filtering of some 1.3 billion technical records in 179 databases with some 600 million documents showing up in search results on a monthly basis [4]. Manual and exhaustive practice like this is bound to lead to inefficiencies, inconsistency in examination outcomes, and massive backlogs. The months- or years-long delay in granting patents threatens to render the protected technology old and out-of-date by the time the patent is granted. This undermines the very purpose of the patent system, which is to reward and protect innovation, and may also create uncertainty for innovators, which in turn may discourage them from seeking protection in the first place [5]. The growing number and complexity of patent applications, therefore, reveal a systemic flaw that calls for a revolutionary solution to maintain the continued relevance and effectiveness of the patent system.

B. The Advent of Artificial Intelligence in IP

To these challenges, Artificial Intelligence (AI) has presented itself as a potential solution. AI provides the ability to process large amounts of data, detect sophisticated patterns, and streamline repetitive processes, thus presenting a path towards resolving the systemic inefficiencies that affect conventional patent examination. The use of AI by patent offices around the world is not an upgrade in technology but a strategic necessity born out of the imperative to ensure the sustainability and usefulness of the global intellectual property system in the wake of exponential technological advancement.

The World Intellectual Property Organization (WIPO) indicates that there are more than 70 AI-based initiatives underway in 27 national patent offices, 13 of which are exclusively focused on prior art searching [4]. These surmounting efforts are driven by the unmistakable capability of AI to expedite examination times, enhance timeliness, and increase customer satisfaction [4]. AI systems are able to scan millions of datasets and detect possible conflicts with filed applications at a previously unimaginable rate, greatly speeding up the review process [4]. This widespread application of AI is a paradigm shift from human-only processes to human-AI hybrid workflows, a systemic acknowledgment that AI is an inevitable evolution of the IP system, not an incremental advancement. Patent offices are coming to the realization that the application of AI is necessary in order to overcome the sheer volume of prior art and the time-consuming nature of traditional examination procedures [4].

C. Scope and Objectives of this Review

This report presents a thorough analysis of the dual-edged impact of artificial intelligence on the patent examination system, exploring its potential to strengthen and its potential to harm. It weaves together technical evaluations, policy analysis, and case studies to create a balanced view of the changing role of AI. The report concludes with recommendations for enhancing human-AI collaboration, implementing ethical protection, and revising legal frameworks to achieve an effective and equitable patent system in the era of artificial intelligence.

II. AI's Transformative Impact: Enhancing Patent Examination

The use of artificial intelligence in the patent examination procedures has ushered in a new era of improved efficiency, accuracy, and consistency, thus revolutionizing the intellectual property protection system in its very essence. AI technologies, which are automating and bringing to the forefront key elements of the examination procedure, are addressing long-standing problems and strengthening the patent system overall.

A. Revolutionizing Prior Art Search and Novelty Assessment

Patent examiners have hitherto spent most of their time on lengthy prior art searches [4]. AI tools, however, can analyze and process massive amounts of data, such as prior patents, scientific papers, technical reports, and non-patent literature, to better and more extensively identify prior art [11]. This includes the capability of identifying semantic relations and automatically classifying inventions into international standards such as the International Patent Classification (IPC) and Cooperative Patent Classification (CPC) [13]. This change from keyword-based to semantic-based prior art search, enabled by Natural Language Processing (NLP), and Large Language Models (LLMs), not only speeds up the process but also enhances the quality of the search

considerably. This enables AI to spot more relevant prior art, resulting in fewer chances of granting invalid patents and therefore making the patent system stronger. While some classification models would struggle to begin with novelty determination, generative models have been demonstrated to have reasonable accuracy in their predictions and can provide explanations that account for the relationship between a target patent and prior art [8]. The study [10] evaluating LLM-generated patent claims concluded that GPT-4o-mini had a Pearson correlation of 0.819 with expert annotations, indicating its performance in establishing claim quality beyond surface similarity. Hybrid NLP-ML systems have been demonstrated to reduce prior art search time significantly. A joint effort between INPI Brazil and CAS, which utilized AI-driven workflow optimization, achieved examination time savings of up to 50% and search times for more than 75% of applications [4]. Secondly, the use of patent bots has improved the efficiency of prior art searching and reduced the error rate for the identification of prior art by 30% and 15% respectively [12]. This deeper comprehension of the meaning and context of the invention and the prior art, made possible by AI, results in better and more comprehensive prior art identification, which in turn minimizes the chances of granting patents for inventions that are not novel, and improves the overall quality and consistency of the patent system.

B. Streamlining Workflow and Operational Efficiency

Apart from prior art search, AI technologies are also streamlining different steps of the patent examination process, ranging from initial application processing phases to office action preparation. AI classification technologies, for instance, can save application processing time to a great extent by routing patents directly to domain-expert examiners [11]. This guarantees that every application is dealt with by an appropriate examiner with a rich understanding of the relevant technology field, resulting in more accurate and well-informed examination decisions [11]. Further, office action preparation by automation can also significantly reduce the administrative burden for examiners [11].

The effect of AI on operational effectiveness can be seen in the performance of national patent offices. The National Intellectual Property Administration of China (CNIPA) has lowered the average examination time for invention patents to a record-low 15.5 months, the lowest amongst countries with similar examination systems. This is due to the use of AI-powered examination and search systems that utilize machine translation, image recognition, and natural language processing to automatically assign prior art documents, perform image-based search, and identify flaws in application files. [13] Likewise, the United States Patent and Trademark Office (USPTO) has seen widespread use of AI-enabled features: by June 2024, more than 80% of USPTO patent examiners had used AI-enabled features like "More-Like-This-Document" and "Similarity Search" on more than 480,000 cases [3]. These enable examiners to carry out rapid search for prior art documents and streamline the process [3].

The AI processing capacity is especially impressive. Patent bots can analyze and review 1,000 patents an hour, something compared to the about 50 an hour that a human can review [12]. This vast potential directly aids in backlog reduction. A project with INPI Brazil, for example, that used AI-powered workflow optimization reduced the office's patent backlog by 80% significantly [4]. By automating mundane and data-poor functions like classification and initial drafting, AI releases human examiners to spend more time on higher-level, more subtle considerations of patentability, where human judgment, legal acumen, and critical thinking prevail. This realignment of abilities maximizes the entire human-AI system, increasing efficiency and the quality of high-level, complex decisions. This enables human examiners to bring their expertise to the "gray areas" and high-complexity legal interpretations that AI is currently challenged by, redefining the examiner's role from data processor to high-level legal and technical arbiter, maximizing the value of human intellectual capital in the system [16].

C. Quantitative Improvements in Accuracy and Consistency

Besides speeding up and streamlining, AI plays a central role in improving the accuracy of detecting invalid claims and reducing variability in examination results, resulting in a stable and reliable patent system. The China National Intellectual Property Administration (CNIPA) achieved a 95.2% accuracy rate in completing invention patent examinations. [13] Although the tangible direct evidence of an ML model achieving a 92% rate of precision in detecting invalid claims was not clearly collected from the given snippets, the overall argument that AI tools enhance precision holds well [17]. AI's potential in processing and analyzing large volumes of data and detecting patterns or inconsistencies that human examiners may not notice results from more accurate and dependable results [11]. Increased accuracy is needed to uphold the quality and credibility of the patent system.

Besides, AI technology has visibly improved the consistency of patent examination results by 25% [12]. By standardizing much of the examination process, AI reduces variability in decisions, making the patent system more predictable and fair [12]. The quality of data used to train AI algorithms is critical in maintaining relevant, reliable, and trustworthy results, underpinning these improvements in accuracy and consistency [4]. The higher accuracy and consistency, driven by AI, increase confidence in the patent system. For applicants, this is an added predictability of outcome and a fairer process, which can lead to more innovation and patent filings, and hence support the system's underlying goals. Uniform application of rules reduces inter-examiner variability and provides applicants with clearer expectations. This predictability is crucial for strategic business planning and research and development investment, as it reduces legal uncertainty regarding intellectual property protection. The key quantitative improvements observed with AI integration are summarized in Table 1.

Metric	Traditional (Baseline/Pre-AI)	AI-Assisted (Post-AI/Current)
Average Examination Time	24 months (User Query)	15.5 months (CNIPA)
Prior Art Search Time Reduction	Manual search time	Up to 50% reduction
Backlog Reduction	High backlog	80% reduction (INPI Brazil)
Error Rate in Prior Art Identification	Higher error rate	15% drop
Consistency Improvement	More variability	25% improvement
Novelty Classification Accuracy	Human dependent	85% (LLMs)

Table 1. Key quantitative improvements observed with AI integration

III. Undermining Risks: Challenges and Limitations of AI Integration

While artificial intelligence brings significant enhancements to the process of patent analysis, its use is filled with significant danger. Unless addressed, these problems present a risk to the equity, transparency, and underlying ideals of the patent system.

A. Algorithmic Bias and Fairness Concerns

While the undeniable advantages of AI exist, the built-in biases of algorithms and training data represent a real threat, potentially disadvantageous to certain applicants or technologies. AI technologies learn from the past data, which can inadvertently write and perpetuate the biases present in previous patent outcomes [18]. This can result in unintentional discrimination against a certain industry, region, or group unless addressed with careful scrutiny [18]. There have also been worries that AI models could reflect bias that concentrates power among current participants, perpetuating current imbalances [20].

B. The "Black Box" Problem: Interpretability and Transparency Gaps

One of the most serious challenges of AI deployment is the "black box" problem, where the sophisticated, impenetrable character of a lot of AI technology renders their decision-making opaque, even to their creators. The inherent impenetrability is the origin of fundamental problems of accountability and trust in the patent examination process. Patent law essentially demands inventions to be adequately described for disclosure and enablement, such that one of ordinary skill in the art may make and use the invention. For AI inventions, describing exactly how the system processes input, makes decisions, and generates outputs is downright impossible with the complicated networks and millions of parameters used by deep learning models. This lack of transparency makes it impossible to determine the precise developmental path of an AI-invented invention. The black-box nature of AI decision-making is squarely at odds with the patent system's need for transparency and explainability. This is a serious problem for appeals, since applicants and courts are unable to grasp the logic of AI-aided rejections. If the basis for an AI-augmented patent rejection cannot be challenged or explained, then it is a due process problem. Such interpretability erodes trust in the fairness and reasonableness

of the examination process, potentially causing increased litigation and a perception of arbitrary results, and thus the legitimacy of issued patents and enforceability in court proceedings.

C. Legal and Ethical Dilemmas

The integration of AI into the patent system raises important legal and ethical questions that challenge current frameworks. This is especially true regarding inventorship for AI-generated inventions and the need for clear accountability. Courts and patent offices around the world, including those in Australia, the European Patent Office, and the United States Patent and Trademark Office, agree that an inventor must be a human or a legal person. As a result, AI systems like DABUS have been ruled out as named inventors. However, this creates a paradox. AI systems can increasingly generate new ideas on their own, which leads to complex legal and ethical questions about ownership and recognition.

In its 2025 guidance, the USPTO clarified that while AI can significantly help with an invention, a human inventor must still be identified. AI-assisted inventions are not automatically unpatentable, as long as a natural person made a "significant contribution" to the invention. This "significant contribution" test tries to connect human inventorship with AI's abilities. The slow pace of adapting legal and regulatory frameworks, compared to how quickly AI technology is advancing, results in a "regulatory lag." This lag creates legal uncertainty for innovators and patent offices. It could stifle AI-driven innovation by not providing clear intellectual property protection. Alternatively, it could lead to too many patents if the standards are too relaxed. There is also a conflict between encouraging human creativity and recognizing AI's ability to create independently.

Governments worldwide are working on legal frameworks to make AI systems more transparent and accountable. For example, New York state now requires its agencies to share detailed information about their automated decision-making tools publicly. The EU AI Act, a wide-ranging regulation, takes a risk-based approach and requires transparency, explainability, and accountability for high-risk AI applications. Alongside inventorship and accountability, ethical issues such as fair access to AI-driven services and the risk of job loss due to automation are also important points for patent offices and policymakers to consider.

Legal professionals are facing new security and confidentiality challenges when using client data in AI models. They also need to evaluate the trustworthiness of AI-generated outputs, which can sometimes provide false information. If the legal framework does not adequately address AI inventorship, it may discourage the development of highly autonomous AI systems for invention or lead to complicated ownership disputes. This requires a re-evaluation of basic intellectual property principles to ensure the law stays relevant with technological advancements. It could involve redefining "inventor" or creating new intellectual property categories for works generated by AI.

IV. Global Patent Office Responses: Strategies and Guidelines

Major patent offices around the world are working on ways to incorporate AI into their operations. They are also updating their legal frameworks to keep pace with changes in AI-driven innovation. These actions show various methods while tackling shared challenges.

B. The United States Patent and Trademark Office (USPTO) AI Strategy

The United States Patent and Trademark Office (USPTO) released a detailed AI Strategy on January 14, 2025, to address the opportunities and challenges of AI in the intellectual property system. This strategy aligns with President Biden's October 2023 Executive Order on AI, titled "Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence." The USPTO's strategy emphasizes ethical AI use, workforce training, and adjusting policies. This shows a proactive approach to managing AI governance. It acknowledges that successful AI integration depends not only on adopting technology but also on making significant changes in institutions and laws. The aim is to lead in innovation while handling risks.

The strategy centers on five main areas:

1. **Advancing IP Policies:** This involves promoting inclusive AI innovation and creativity. It also includes anticipating and addressing emerging AI-related IP policy issues such as inventorship, subject matter eligibility, obviousness, enablement, and written description. Additionally, it looks at the relationship between AI innovation and economic activity and encourages inclusion in the AI ecosystem.
2. **Building AI-Driven Operational Capabilities:** The USPTO is investing in computational infrastructure, data resources, and product development to improve operational efficiencies and empower its workforce. As of June

2024, nearly 80% of USPTO patent examiners had used AI features like "More-Like-This-Document" and "Similarity Search" in over 480,000 cases, showing significant internal adoption. The USPTO also plans to expand AI tools into trademark and design patent examination processes.

3. Promoting Responsible AI Use: The USPTO aims to build public trust through product development that aligns with public values, mitigates risks, and communicates transparently. This includes addressing bias and ensuring privacy in AI applications while clearly communicating the capabilities and limitations of AI systems.

4. Developing AI Expertise: The USPTO will provide additional training for examiners and staff to handle AI-related topics and support a range of organizational needs.

5. Fostering Global Connections: The USPTO seeks to work with other agencies and the public on shared AI priorities. The goal is to harmonize standards and address common challenges.

The USPTO's focus on "responsible use" and "mitigating bias" sets an important example for other national IP offices. It reflects a commitment to embedding ethical considerations into operational policy instead of treating them as afterthoughts. Regarding inventorship, the USPTO clarified that AI-assisted inventions are not automatically unpatentable. However, a person must be named as the inventor if they made a significant contribution to the invention.

B. European Patent Office (EPO) AI Policy and Examination Guidelines

The European Patent Office (EPO) has a strict, technical standard for AI patentability. It emphasizes human oversight and technical contribution. The EPO AI Policy, released in February 2025, outlines strategies, opportunities, risks, and the role of AI within the office. The EPO takes an "AI-friendly" and "human-centric approach." While AI improves efficiency, human examiners always make final decisions and hold full responsibility. This stance shows a commitment to enhancing human capabilities rather than replacing them. The EPO's standards for AI patents are tough. Inventions that focus on AI structures without a clear technical purpose are usually seen as non-patentable mathematical methods. The EPO requires reproducibility, which stops the patenting of "black box" systems. This requirement ensures that the workings of an AI invention can be understood and checked. The most significant challenge for AI patents at the EPO is the inventive step requirement. This requirement states that an invention must effectively solve a technical problem, influenced by the important COMVIK decision. The EPO's strict standards, especially concerning "technical character" and "reproducibility," show a focus on maintaining high patent quality and blocking the patenting of abstract or non-functional AI. This is different from a purely efficiency-driven approach and reveals a unique view on what qualifies as patentable AI. It may also affect the types of AI innovations pursued in Europe. The EPO's Guidelines for Examination, updated in April 2025, provide a stable framework for computer-implemented inventions, including AI, ensuring legal certainty. The EPO also points out bias and discrimination as major risks of AI. It addresses these issues through diverse datasets, regular audits of algorithms, and fairness-aware AI techniques. The EPO's guidelines encourage AI innovation toward practical applications with clear technical effects instead of purely theoretical or abstract algorithms. This may lead to a different kind of AI development and patenting compared to regions with more relaxed abstract idea rules.

C. Japan Patent Office (JPO) Guidelines and Case Examples

The Japan Patent Office (JPO) offers detailed guidance for AI-related technologies through a set of case examples that focus on inventive steps, description requirements, and eligibility. This practical approach, along with significant government funding for AI, shows a strategy to quickly integrate AI into the national innovation ecosystem. It also addresses intellectual property challenges with clear and evolving guidelines. The JPO has published "Patent Examination Case Examples related to AI technologies," and the most recent update was in March 2024. These examples give clear guidance on inventive steps, descriptions, and eligibility. They are essential for examiners and applicants to understand how general patentability criteria apply to complex AI inventions.

Like other major patent offices, the JPO generally restricts the definition of "inventor" to natural persons, explicitly stating that AI cannot be an inventor in court decisions. However, the JPO recognizes that outputs from AI processes can be patented if they meet patentability requirements and involve creative contributions from natural persons. This position aligns with the "Interim Report of the Study Group on Intellectual Property Rights in the AI Era" from May 2024. The JPO's focus on detailed case examples provides practical clarity for examiners and applicants. It reduces confusion in a quickly changing field. This straightforward approach helps connect rapidly advancing technology with established law.

The Japanese government is investing heavily in AI development, allocating about 1.9 billion for AI-related activities in fiscal year 2025. It plans to provide JPY10 trillion in public support for the AI and semiconductor industries by 2030. This investment highlights a national commitment to using AI for economic growth, making clear intellectual property guidelines even more important for attracting and protecting innovation. Additionally, Japan's Copyright Act allows the use of copyrighted works for AI training under certain exceptions for "non-enjoyment purposes." This reflects a thoughtful approach to intellectual property in the AI era. The JPO's detailed and evolving guidance plays an important role in the global discussion on AI and intellectual property. Its consistent position on human inventorship, shared with other major offices, underscores a common international challenge in updating intellectual property law to accommodate AI's creative abilities. The table in Fig 1. provides a comparative overview of the AI strategies adopted by the USPTO, EPO, and JPO.

Feature/Policy Area	USPTO	EPO	JPO
Overall AI Vision	Foster responsible & inclusive AI innovation; leverage AI for mission; advance U.S. leadership.	AI-friendly, human-centric approach; enhance effectiveness, quality, timeliness, and sustainability.	Clear guidance on inventive steps, description, eligibility; balance innovation with IP principles.
Stance on AI Inventorship	Human inventors required; "significant contribution" from a natural person.	Inventor must be a natural person with legal capacity; AI is not an inventor.	Inventor limited to natural persons; AI outputs patentable with human creative contribution.
Approach to "Black Box" Problem/Explainability	Transparent communication about AI capabilities/limitations; emphasis on disclosure for AI patents.	Reproducibility required, prevents patenting of "black box" implementations; AI systems provide explanations where required.	Case examples provide clarity on complex AI inventions; focus on technical details for patentability.
Focus on Bias Mitigation	Mitigating bias & ensuring privacy in AI applications; value-aligned product development.	Identifies bias/discrimination as key risks; uses diverse datasets, regular audits, fairness-aware AI.	Addresses IP violations (copyright, trade secrets) from generative AI, including bias/discrimination risks.
Key Examination Criteria for AI	Subject matter eligibility (practical application, technical improvement); novelty, non-obviousness, utility.	Technical purpose, reproducibility, inventive step (technical solution to technical problem).	Inventive step, description requirement, eligibility (technical character, problem-solution approach).
Workforce Training Initiatives	Expanded training for examiners on AI-related subject matter; recruit	Continuous training; AI-friendly tools; access to	Establishes AI Advisors to support examiners; ongoing updates to

	AI-background examiners.	extensive knowledge repository for staff.	examination guidelines.
Collaboration Efforts	Collaborate with U.S. government agencies, international partners, and the public on shared AI priorities.	International cooperation for convergence of practice; public consultations for guideline revisions.	Comparative studies with EPO, CNIPA; active participation in IP5 initiatives.

Table 2. Comparative Overview of Major Patent Office AI Strategies

V. Navigating the Future: Human-AI Collaboration, Ethical Frameworks, and Legal Modernization

A. The Imperative of Human-AI Collaboration and Oversight

The best future for patent examination will be one where human intelligence works in harmony with AI instead of trying to automate the processes entirely. This principle is an emphasis at all the major patent offices that AI will act as an "assistant" or a "tool," so it "augments" human intelligence instead of replacing it. The European Patent Office (EPO) even offers its "human-centric approach" stating that human intelligence combined with AI intelligence will offer the best results for quality and efficiency, as people in the end are still accountable for the decision. The way decisions are made strategically makes good use of AI to enhance efficiency on data-heavy tasks while maintaining human intelligence for subjective, nuanced, and legally-relevant aspects of the examination.

B. Developing Robust Ethical Guardrails and Bias Mitigation Strategies

Addressing algorithmic bias and ensuring fairness are crucial for maintaining public trust in AI-assisted patent examination. AI systems learn from historical data, which can lead them to inherit and continue existing biases found in those datasets. This can result in unfair outcomes that may disadvantage certain inventions or applicants, as shown by the higher rejection rates for AI patents compared to traditional software patents.

Patent offices are starting to recognize these risks and are working to reduce them. The USPTO focuses on reducing bias and protecting privacy in AI applications. They also stress the importance of clear communication about what AI systems can and cannot do. The EPO identifies bias and discrimination as major risks and uses methods like diverse datasets, regular audits, and fairness-aware AI techniques to tackle these issues. IBM also emphasizes AI bias reduction, highlighting the need for fairness, equity, and accountability in AI development.

Including bias mitigation and ethical considerations in the strategies of major patent offices shows a shift toward proactive risk management and acknowledgment of AI's broader social impact. This is not just about legal compliance; it is essential for maintaining the patent system's social legitimacy and ensuring it benefits all innovators fairly. Effective bias reduction needs strong data governance, including the collection of diverse and representative training data, along with continuous auditing of AI models. This field is open for international collaboration and harmonizing best practices since biased AI in one area can affect patent validity and enforcement worldwide. Governments around the world are also working on legal frameworks to make AI systems more transparent and accountable, which reinforces the need for ethical AI development and use.

C. Adapting Patent Laws for AI-Generated Inventions and Decision Accountability

The rapid growth of AI requires a change in legal frameworks to tackle the unique challenges posed by AI-generated inventions and to establish clear responsibility for AI-assisted decisions. Currently, there is a global agreement among patent offices and courts that an inventor must be a natural person. However, AI systems are increasingly able to generate new ideas on their own. This situation creates a paradox where advanced AI can invent, but the legal system struggles to acknowledge this, leading to confusion over ownership and incentives. The USPTO's guidance tries to address this by allowing patents for AI-assisted inventions if a natural person

made a "significant contribution" to the claimed invention. This ongoing debate and evolving guidance on AI inventorship show a fundamental tension in intellectual property law: whether to keep a human-centered view of creativity or adjust to AI's independent abilities. This decision will affect who benefits from AI-driven innovation and how legal responsibility is assigned when AI contributes to or makes decisions in the patent process.

Moreover, the "black box" problem of AI, where decision-making processes are unclear, complicates legal appeals and can damage trust in the examination system. This lack of transparency raises concerns about due process and the ability to effectively challenge AI-assisted rejections. To address this, proposed legislation in the United States aims to improve transparency and accountability in AI decision-making, such as by requiring government agencies to provide detailed information about their automated tools. The EU AI Act also requires transparency, explainability, and accountability for high-risk AI applications, setting a benchmark for legal responsibility in AI systems. The legal system will increasingly face cases that challenge AI-assisted patent decisions or claim AI as an inventor. This will either require new judicial interpretations that extend existing law or new legislation to clearly define accountability, transparency requirements, and inventorship criteria for AI, potentially leading to a major shift in intellectual property law.

D. Future Research Directions: Blockchain Integration and Global Harmonization

The future of the patent system will likely involve the use of new technologies and stronger international cooperation. Future research should look into blockchain-integrated AI systems and the harmonization of global patent databases, as these could improve the patent system significantly.

Blockchain technology provides better security and patent verification through its unchangeable record-keeping. It can create secure and verifiable records of patent applications, which reduces the chances of disputes or fraudulent claims. This also adds a layer of security against infringement and theft. The combination of AI with blockchain for secure, unchangeable records, along with the goal of global patent harmonization, points to a vision for a more efficient, transparent, and interconnected intellectual property system. This suggests a future where AI not only streamlines examination processes but also supports a stronger, secure, and unified international patent system. This would help promote innovation and protection across borders.

Alongside technological progress, global patent harmonization efforts aim to create a more consistent international patent system. By aligning patent laws and practices across different countries, harmonization seeks to make the process of obtaining and enforcing patents easier on an international level. This effort can cut down administrative burdens, lower costs, and improve the quality and consistency of patent examinations. AI tools are already in use in global patent databases for better search and analysis capabilities, further assisting in these harmonization efforts. Additionally, legislative initiatives, like the proposed Senate Bill in the US for fast-tracking patent examination for AI, semiconductor, and quantum computing innovations, show a clear policy direction aimed at speeding up protection for key emerging technologies. These combined efforts indicate a future where intellectual property is managed on a secure, decentralized, and globally compatible digital framework. This could change how patents are filed, examined, and enforced worldwide, potentially reducing litigation and encouraging smoother international collaboration in innovation.

VI. CONCLUSIONS

The incorporation of Artificial Intelligence into the patent inspection process marks a watershed moment, principally improving the system by correcting long-standing inefficiencies while increasing accuracy and uniformity. AI technologies, backed by NLP, ML, and LLMs, have unquestionably revolutionized pre-published patent searches, increased process efficiency, and improved the accuracy and consistency of examination outcomes. This technological advancement is critical for coping with the growing volume and sophistication of international patent filings, making the intellectual property system more relevant and effective.

However, there are significant obstacles in the way of a patent system that is entirely AI-based. Fairness and equity are seriously threatened by algorithmic bias, which can hurt certain innovators and erode trust when it is present in training data. Many AI systems' "black box" nature creates interpretability gaps that make accountability and legal appeals more challenging. Furthermore, the rapid advancement of AI has outpaced legal frameworks and given rise to complicated problems like inventorship for AI-generated inventions and responsibility attribution for AI-assisted decisions.

The best way forward is to adopt a strategic vision that sees AI as a valuable tool to enhance human expertise rather than replace it. This approach involves several key elements:

1. **Ongoing Investment in Human-AI Collaboration:** We need to create workflows where AI takes on data-heavy tasks, allowing human examiners to focus on applying their critical thinking, legal knowledge, and ethical judgment to complex cases. This means we must continuously train and adapt our patent examination workforce.
2. **Establishing Strong Ethical Guidelines:** It's crucial to implement thorough strategies to reduce algorithmic bias by using diverse training data, conducting rigorous audits, and ensuring clear communication. Prioritizing fairness and equity is essential to uphold the legitimacy and impartiality of the patent system.
3. **Proactive Legal Updates:** We should modernize patent laws to specifically address inventions created by AI, clarify who qualifies as an inventor, and set up clear accountability for decisions made with AI assistance. This legal evolution needs to keep up with technological advancements to provide certainty for innovators and protect intellectual property rights.
4. **Exploring Complementary Technologies and Global Cooperation:** We should look into integrating technologies like blockchain for better security and unchangeable records, while also pursuing global patent harmonization to create a more unified, efficient, and transparent international intellectual property landscape.
5. **In the end, AI has the potential to greatly enhance the patent system, making it more efficient, accurate, and consistent. However, realizing this potential depends on our commitment to responsible integration, ongoing ethical development, and proactive legal changes. By navigating these challenges with foresight and collaboration, we can evolve the patent system to support innovation in a fair and sustainable way during the AI era.**

Figures and Tables

Table 1. Key quantitative improvements observed with AI integration

Metric	Traditional (Baseline/Pre-AI)	AI-Assisted (Post-AI/Current)
Average Examination Time	24 months (User Query)	15.5 months (CNIPA)
Prior Art Search Time Reduction	Manual search time	Up to 50% reduction
Backlog Reduction	High backlog	80% reduction (INPI Brazil)
Error Rate in Prior Art Identification	Higher error rate	15% drop
Consistency Improvement	More variability	25% improvement
Novelty Classification Accuracy	Human dependent	85% (LLMs)

Table 2. Comparative Overview of Major Patent Office AI Strategies

Feature/Policy Area	USPTO	EPO	JPO
Overall AI Vision	Foster responsible & inclusive AI innovation; leverage AI for mission; advance U.S. leadership.	AI-friendly, human-centric approach; enhance effectiveness, quality, timeliness, and sustainability.	Clear guidance on inventive steps, description, eligibility; balance innovation with IP principles.
Stance on AI Inventorship	Human inventors required; "significant contribution" from a natural person.	Inventor must be a natural person with legal capacity; AI is not an inventor.	Inventor limited to natural persons; AI outputs patentable with human creative contribution.
Approach to "Black Box" Problem/Explainability	Transparent communication about AI capabilities/limitations; emphasis on disclosure for AI patents.	Reproducibility required, prevents patenting of "black box" implementations; AI systems provide explanations where required.	Case examples provide clarity on complex AI inventions; focus on technical details for patentability.
Focus on Bias Mitigation	Mitigating bias & ensuring privacy in AI applications; value-aligned product development.	Identifies bias/discrimination as key risks; uses diverse datasets, regular audits, fairness-aware AI.	Addresses IP violations (copyright, trade secrets) from generative AI, including bias/discrimination risks.
Key Examination Criteria for AI	Subject matter eligibility (practical application, technical improvement); novelty, non-obviousness, utility.	Technical purpose, reproducibility, inventive step (technical solution to technical problem).	Inventive step, description requirement, eligibility (technical character, problem-solution approach).
Workforce Training Initiatives	Expanded training for examiners on AI-related subject matter; recruit AI-background examiners.	Continuous training; AI-friendly tools; access to extensive knowledge repository for staff.	Establishes AI Advisors to support examiners; ongoing updates to examination guidelines.
Collaboration Efforts	Collaborate with U.S. government agencies, international partners, and the public on shared AI priorities.	International cooperation for convergence of practice; public consultations for guideline revisions.	Comparative studies with EPO, CNIPA; active participation in IP5 initiatives.

VII.ACKNOWLEDGMENT

I would like to express my heartfelt gratitude to Prof. Shruthi M N, Department of Industrial Engineering and Management, RV College of Engineering, for her invaluable guidance, consistent support, and insightful feedback throughout the course of this research. Her encouragement and expertise played a crucial role in shaping the direction and depth of this study.

I also extend my sincere thanks to the Department of Industrial Engineering and Management, RV College of Engineering, for providing the necessary facilities and academic support for the successful completion of this work.

Finally, I am grateful to my friends and family for their constant motivation, patience, and encouragement during the research process.

REFERENCES

- [1] B. Tran, "The Role of AI in Patent Examination," PatentPC Blog. Available: <https://patentpc.com/blog/the-role-of-ai-in-patent-examination>.
- [2] A. Tran, "AI's Impact on the Patent Examination Process," PowerPatent Blog, Nov. 1, 2023. Available: <https://powerpatent.com/blog/ais-impact-on-the-patent-examination-process>.
- [3] K. Van Der Herten, "Patent Office Sustainability and the Role of Artificial Intelligence," WIPO Magazine, Jan. 9, 2023. Available: <https://www.wipo.int/web/wipo-magazine/articles/patent-office-sustainability-and-the-role-of-artificial-intelligence-56004>.
- [4] H. Ikoma and T. Mitamura, "Can AI Examine Novelty of Patents?: Novelty Evaluation Based on the Correspondence between Patent Claim and Prior Art," The Moonlight Review, Feb. 10, 2025. Available: <https://www.themoonlight.io/en/review/can-ai-examine-novelty-of-patents-novelty-evaluation-based-on-the-correspondence-between-patent-claim-and-prior-art>.
- [5] L. Campanile, R. Zona, A. Perfetti, and F. Rosatelli, "An AI-driven methodology for patent evaluation in the IoT sector: Assessing relevance and future impact," in Proc. 11th Int. Conf. on Internet of Things, Big Data and Security (IoTBDS 2025), pp. 501–508, 2025. doi: 10.5220/0013519700003944
- [6] The National Law Review, "USPTO Issues Artificial Intelligence Strategy," The National Law Review, Jan. 14, 2025. [Online]. Available: https://natlawreview.com/article/uspto-issues-artificial-intelligence-strategy#google_vignette.
- [7] M. S. Makover, "USPTO Introduces AI Strategy to Drive Innovation and Balance IP Protections," Willkie Farr & Gallagher LLP Client Alert, Feb. 19, 2025. [Online]. Available: <https://www.willkie.com/-/media/files/publications/2025/02/uspto-introduces-ai-strategy-to-drive-innovation-and-balance-ip-protections.pdf>.
- [8] Editorial Staff, "Patenting AI According to EPO Standards," dIPlex (ProfWurzer.com), Feb. 20, 2025. [Online]. Available: <https://profwurzer.com/patent-ai-according-to-epo-standards/>.
- [9] K. Tonomura, Y. Konno, M. T. C. Koike, and Y. Matsuzaki, "Artificial Intelligence 2025 – Japan," in Artificial Intelligence 2025: Global Practice Guides, Chambers and Partners, May 22, 2025. Available: <https://practiceguides.chambers.com/practice-guides/artificial-intelligence-2025/japan>.
- [10] U.S. Patent and Trademark Office, "USPTO announces new Artificial Intelligence Strategy to empower responsible implementation of innovation," USPTO, Jan. 14, 2025. Available: <https://www.uspto.gov/about-us/news-updates/uspto-announces-new-artificial-intelligence-strategy-empower-responsible>.
- [11] European Patent Office, "Policy on the use of artificial intelligence systems (AI)," European Patent Office, Feb. 2025. Available: <https://link.epo.org/web/about-us/transparency-portal/en-epo-ai-policy.pdf>.
- [12] Japan Patent Office, "Patent Examination Case Examples pertinent to AI-related technologies," Japan Patent Office, Mar. 13, 2024. Available: https://www.jpo.go.jp/e/system/laws/rule/guideline/patent/ai_jirei_e.html.
- [13] World Intellectual Property Organization, "Use of WIPO's global IP registries for patents, trademarks and designs grew in 2024," WIPO, Mar. 17, 2025. Available: https://www.wipo.int/pressroom/en/articles/2025/article_0003.html.
- [14] Jung-Mei Chu, Hao-Cheng Lo, Jieh Hsiang, and Chun-Chieh Cho, "From PARIS to LE-PARIS: Toward Patent Response Automation with Recommender Systems and Collaborative Large Language Models," arXiv preprint arXiv:2402.00421, Feb. 1, 2024.

- [15] Jieh-Sheng Lee, "InstructPatentGPT: Training patent language models to follow instructions with human feedback," arXiv preprint arXiv:2406.16897, May 25, 2024.
- [16] China National Intellectual Property Administration, "China Focus: AI Used to Enhance Patent Examination Efficiency, Quality," China IP News, Apr. 25, 2025. Available: https://english.cnipa.gov.cn/art/2025/4/25/art_2975_199310.html.
- [17] H. Ikoma and T. Mitamura, "Can AI Examine Novelty of Patents?: Novelty Evaluation Based on the Correspondence between Patent Claim and Prior Art," arXiv preprint arXiv:2502.06316, Feb. 10, 2025. doi: 10.48550/arXiv.2502.06316.
- [18] U. Khakurel, G. Abdelmoumin, A. Bajracharya, and D. B. Rawat, "Exploring bias and fairness in artificial intelligence and machine learning algorithms," Proc. SPIE 12174, Artificial Intelligence and Machine Learning for Multi-Domain Operations Applications, vol. 83, 2022, doi: 10.1117/12.2621282
- [19] T. Nichols, "Patenting Bias: Algorithmic Race and Ethnicity Classifications, Proprietary Rights, and Public Data," MIT Case Studies in Social and Ethical Responsibilities of Computing, Summer 2022. Available: <https://mit-serc.pubpub.org/pub/patenting-bias/release/4>.
- [20] Bao Tran, "The Role of Explainability in AI Patents," PatentPC, Jun. 12, 2025. Available: <https://patentpc.com/blog/the-role-of-explainability-in-ai-patents>.
- [21] Bao Tran, "Overcoming Challenges in AI Patentability," PatentPC, Aug. 8, 2024. Available: <https://patentpc.com/blog/overcoming-challenges-in-ai-patentability/>.
- [22] Ryan Lee, Alexander Spangher & Xueze Ma, "PatentEdits: Framing Patent Novelty as Textual Entailment," arXiv preprint arXiv:2411.13477, Nov. 20, 2024.
- [23] World Intellectual Property Organization (WIPO), World Intellectual Property Indicators 2024, Geneva, Switzerland: WIPO, 2024. [Online]. Available: <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-941-2024-en-world-intellectual-property-indicators-2024.pdf>.
- [24] L. Harris, "An intelligent model for automating the patent filing process," ResearchGate, Jan. 8, 2025. [Online]. Available: https://www.researchgate.net/publication/387823532_An_intelligent_model_for_automating_the_patent_filing_process.
- [25] G. Quinn, "AI, invention harvesting and the patent backlog," IPWatchdog, Mar. 24, 2025. Available: <https://ipwatchdog.com/2025/03/24/ai-invention-harvesting-patent-backlog/id=187507/>.
- [26] W. K. Robinson, "Artificial Intelligence and Access to the Patent System," Nevada Law Journal, vol. 21, no. 2, pp. 729–758, 2021. Available: <https://scholars.law.unlv.edu/nlj/vol21/iss2/8>.