INDUSTRIAL PROPERTY OF PATENTS GENERATED BY ARTIFICIAL INTELLIGENCE: A SCIENTOMETRIC AND QUALITATIVE ANALYSIS

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1. **ABSTRACT:** The context of the topic is to present briefly the importance of patents in the context of technological innovation and the role of artificial intelligence in generating inventions. The objectives of the article were to explore the existing literature, identify the most cited authors and research directions, and analyze students' perspectives on issues related to the industrial property of patents generated by AI. The aims were to explore the current landscape of patent law as it pertains to AI-generated inventions through a dual approach: a scientometric analysis of the relevant literature and a qualitative study based on semi-structured interviews with master's students. By identifying key research directions and gathering insights from emerging professionals in the field, this study seeks to contribute to the ongoing discourse on the intersection of AI and intellectual property rights. The findings will not only highlight the current state of research. Still, they will also provide a deeper understanding of the implications for future policy and legal frameworks in the realm of industrial property.

2. INTRODUCTION

The advent of artificial intelligence (AI) has revolutionized numerous fields, including technology, healthcare, and finance, by enhancing efficiency and enabling new levels of innovation. One of the most intriguing implications of AI's capabilities is its potential to generate autonomously inventions and designs, raising critical questions about intellectual property rights, particularly in the context of patents. (Schwartz and Rogers 2022a), [1]. Traditionally, patents are granted to human inventors who create novel and useful inventions, but as AI, systems become increasingly sophisticated, the legal and ethical frameworks surrounding patent ownership are being challenged.(Mantegna, [9]; Schwartz and Rogers 2022b, [2]; Sun, 2024, [17].; Afshar 2022a, [1]; Sorjamaa 2016, [16]; Veale, Binns, and Edwards 2018, [19])

The World Intellectual Property Organization (WIPO) has recognized the need for a comprehensive examination of how AI-generated inventions fit within existing patent laws. In its 2020 report, WIPO highlighted that while AI can assist in the invention process, the current legal frameworks in many jurisdictions do not accommodate non-human inventors, thus necessitating a reevaluation of what

constitutes an inventor("Tech trends", [18]). This situation creates a potential gap between technological advancement and the legal protections afforded to inventions, which may hinder innovation and investment in AI technologies.(Bird *et al*.,[5])

Recent studies have begun to explore the implications of AI in patent generation, revealing a range of perspectives on the status of AI as an inventor. For instance, some scholars argue that granting patent rights to inventions created by AI could lead to monopolistic practices and stifle competition (Gans, 2020). Others contend that recognizing AI as an inventor may encourage further innovation by providing legal protections that facilitate research and development (Shlomit Yanisky Ravid *et al.* [15], Adam B. Jaffe, Melissa F. Wasserman, [3].; Picht and Thouvenin 2023[11]; Kumar and Suthar 2024,[8])

This article aims to explore the current landscape of patent law as it pertains to AI-generated inventions through a dual approach: a scientometric analysis of the relevant literature and a qualitative study based on semi-structured interviews with master's students. By identifying the most cited authors and key research directions, as well as gathering insights from emerging professionals in the field, this study seeks to contribute to the ongoing discourse on the intersection of AI and intellectual property rights.

The findings will not only highlight the current state of research but will also provide a deeper understanding of the implications for future policy and legal frameworks in the realm of industrial property.

3. METHODOLOGY

3.1 Scientometric Research:

In a systematic analysis conducted using the Web of Science database, the intersection of industrial property and artificial intelligence was explored, yielding a total of 278 relevant documents. To assess the influence and relevance of these works, bibliometric coupling was applied, enabling the identification of the most cited articles within this field. This approach not only facilitates a deeper understanding of the trends and emerging themes in the intersectional research between industrial property and artificial intelligence but also highlights the significant contributions of authors and institutions within this dynamic domain. The results obtained through this method can provide a solid foundation for the development of future strategies in the research and effective application of artificial intelligence in the context of industrial property.

In the course of this analysis, VOSviewer was employed as a powerful tool for visualizing and exploring the bibliometric networks derived from the identified documents. VOSviewer allows for the creation of visual representations of bibliometric data, facilitating the analysis of relationships among authors, institutions, and keywords within the selected literature on industrial property and artificial intelligence.(VOSviewer, [20])

VOSviewer's capability to analyze keyword co-occurrences enabled us to identify prevalent themes and trends within the literature. This analysis revealed critical areas of focus, such as the implications of artificial intelligence on patent law, the role of machine learning in intellectual property management, and emerging legal frameworks addressing the challenges posed by AI technologies.

On a typical bibliometric network visualization created using VOSviewer, clusters are represented by different colors, with each color indicating a distinct group of related terms or entities. The number of clusters can vary depending on the dataset being analyzed.

For an analysis of terms related to "artificial intelligence" and "intellectual property," figure 1 is a generic map with 5 clusters for 45 keywords wich appear at least 5 times in the abstract and title of the articles.

Research directions generated in scientometric research are:

- Blue: AI Technologies
- Red: Intellectual Property Issues
- Green: Ethical Considerations
- Yellow: Applications and Industries
- Purple: Regulatory and Policy Framework

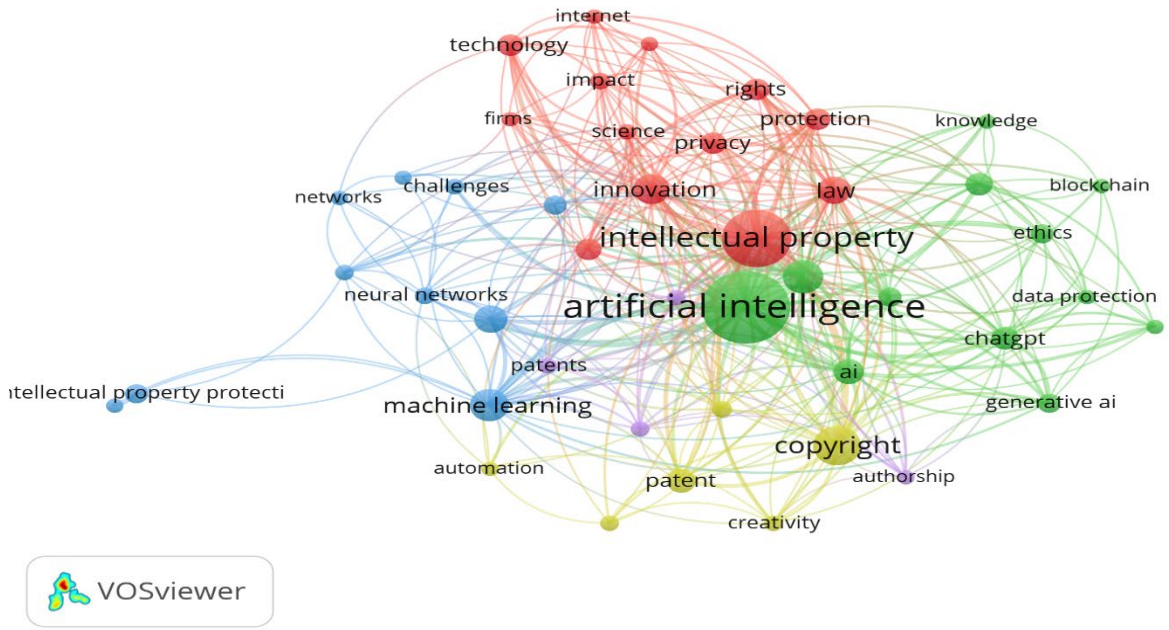

Figure 1: Keyword map

The 5 clusters are described in table 1:

Table 1. Cluster description of the keyword map

Cluster	*Color*	*Terms*	*Description*
1. AI Technologies	Blue	Machine Learning, Neural Networks, Deep Learning	This cluster includes terms that are fundamental to the development and application of AI technologies
2. Intellectual Property Issues	Green	Patents, Copyright, Trademarks, Licensing	This cluster focuses on the legal aspects and protections associated with innovations in AI.
3. Ethical Considerations	Green	Data Privacy, Bias, Accountability, Transparency	This cluster addresses the ethical implications of AI technologies, including concerns about fairness and privacy
4. Applications and Industries	Yellow	Healthcare, Finance, Autonomous Vehicles, Robotics	This cluster highlights various industries where AI is being applied and the associated IP considerations
5. Regulatory and Policy Framework	Purple	Regulation, Policy, Compliance, Standards	This cluster discusses the regulatory environment surrounding AI and IP, including emerging laws and policies.

The integration of VOSviewer into our bibliometric analysis not only enhanced our understanding of the scholarly landscape but also provided a visually compelling narrative of how industrial property and artificial intelligence intersect. This methodological approach underscores the importance of visual analytics in comprehending complex research domains and can serve as a foundation for future investigations aimed at unraveling the evolving relationship between technology and intellectual property rights.

3.2 Qualitative Research

This study employs a qualitative research design, utilizing semi-structured interviews to gather in-depth insights from master's students specializing in intellectual property. The choice of this method is grounded in the need to explore the nuanced opinions and experiences of students regarding the impact of artificial intelligence on intellectual property rights. The semi-structured format allows for flexibility in the conversation, enabling participants to express their thoughts freely while still addressing key topics relevant to the research objectives.

Participant Selection

The participants for this study were selected from a cohort of master's students enrolled in a program focused on intellectual property at Transylvania University of Brasov, Romania. A purposive sampling approach was employed to ensure that participants had relevant academic backgrounds and exposure to the intersection of AI and intellectual property. A total of 25 students were invited to participate in the interviews, with 5 agreeing to take part: Andrea, Stefan, Robert, Ioana, and Claudiu in November-December 2024. The diverse backgrounds of the participants, including varying levels of experience with AI technologies and intellectual property law, provided a rich tapestry of perspectives for analysis.

Data Collection

The data collection process involved conducting semi-structured interviews, each lasting approximately [insert duration] minutes. Interviews were carried out in room GP8, a quiet room at the university, ensuring a comfortable environment conducive to open dialogue. The interviews were guided by a set of open-ended questions designed to prompt discussion on key themes, including:

- Perceptions of the role of intellectual property in the context of AI.
- Challenges faced in protecting intellectual property rights related to AI-generated products.
- Opportunities created by AI for innovation and efficiency in industrial processes.
- Suggestions for adapting current IP frameworks to better accommodate AI technologies.

Each interview was audio-recorded with the participant's consent and subsequently transcribed for analysis.

Data Analysis

Definitions of Artificial Intelligence

1. Andreea: AI is defined as an algorithm that optimizes itself.
   •[Code: AI Definition]
2. Stefan: AI is an umbrella term that encompasses several tools.
   •[Code: AI Definition]
3. Claudiu: AI is a tool that enhances efficiency in the industrial field.
   •[Code: Definition of Artificial Intelligence]
4. Ioana: AI can be defined as a branch of science aimed at making computers capable of performing tasks that typically require human intelligence.
   •[Code: Definition Intelligence Artificial]
5. Robert: AI is a technical and scientific field focused on engineering systems that generate forecasts, recommendations, or decisions for specific objectives.
   •[Code: Definition of Artificial Intelligence]

Applications and Impact of AI

1. Process Automation: AI tools can automate processes requiring intelligent input, such as facial recognition.
   •[Code: Process Automation]
2. Tool for Efficiency: AI serves as a tool to enhance work efficiency.
   •[Code: Tool for Efficiency]
3. Objectives of AI: The goal of AI is to develop machinery that can behave intelligently.
   •[Code: AI Goals]
4. Making Time Efficient: AI can help discover new methods to make time management more efficient and provide complex answers to questions.
   •[Code: The Role of AI in Making Time Efficient]
5. Impact on Innovation: AI significantly influences innovation across various industrial fields.
   •[Code: Impact on Innovation]

6. Impact of AI on Industry: AI has a major impact across all fields and activities.
    •[Code: Impact of AI on Industry]
7. Development of Technical Solutions: AI contributes to creating innovative and effective technical solutions.
    •[Code: Development of Technical Solutions]

Current State of AI

1. Development Period: We are currently in an early stage of AI development, making it difficult to fully analyze its impact.
    •[Code: Development Period]

Summary of Key Points on Industrial Property and AI:

1. Industrial Property Rights:
    - Ownership Issues: The question of ownership arises when a product is invented through AI, leading to discussions on who holds the rights to such creations.
    - Code: Industrial Property Rights
2. Legislation Update
    - Need for Modernization: Current legislation does not adequately address the new requirements and challenges posed by AI technologies.
    - Code: Legislation Update
3. Limitations of AI in Adaptability
    - Human-Like Functionality: AI currently lacks the ability to adapt to scenarios in the same way humans do, which limits its effectiveness in certain contexts.
    - Code: Limitations of AI in Adaptability
4. Copyright Difficulties
    - Challenges Ahead: The rise of AI is expected to create significant challenges for copyright laws as they struggle to keep pace with technological advancements.
    - Code: Copyright Difficulties
5. Major Changes Needed
    - Legislative Reforms: There is a consensus that major changes in legislation are necessary to address the evolving landscape of AI and IP.
    - Code: Major Changes Needed
6. Ownership of AI Creations
    - Determining Ownership: A critical challenge is identifying who owns the creations generated by AI models—whether it be the creator, the user, or the AI itself.
    - Code: Ownership of AI Creation
7. Challenges in IP Protection
    - Protection Issues: The development of AI raises questions about the protection of industrial property and the ambiguity surrounding ownership.
    - Code: Challenges in IP Protection
8. Ambiguity of Ownership
    - Unpredictability: The unpredictable nature of AI outputs makes it difficult to anticipate ownership scenarios before they arise.
    - Code: Proprietary Ambiguity
9. Ownership of AI-Generated Inventions

- Attribution of Ownership: Inventions produced by AI algorithms could be owned by various parties, including the AI's creator, user, or the AI itself.
- Code: Ownership of AI-Generated Inventions

10. Generating Similar Solutions
    - Imitation of Existing Solutions: AI is capable of generating solutions that resemble or combine existing solutions, raising questions about originality.
    - Code: Generating Solutions Similar
11. Plagiarism and Training Sources
    - Risks of Plagiarism: As AI technology advances, ensuring that AI models do not plagiarize from their training sources becomes a significant concern.
    - Code: Plagiarism and Training Sources
12. Regulatory Ambiguity
    - Confusion in Application: There are ambiguities in existing legislation that can lead to confusion regarding the application of IP protection rules.
    - Code: Regulatory Ambiguity
13. The Problem of Plagiarism
    - Ongoing Concerns: The issue of plagiarism in the context of AI-generated content is a growing problem that needs to be addressed.
    - Code: The Problem of Plagiarism

This structured summary encapsulates the key themes and concerns regarding industrial property rights and the implications of AI, providing a clear overview for further discussion or analysis.

Interpretation of Results

1. Complexity of Ownership:
- The question of ownership in the context of AI-generated creations is complex and multifaceted. As AI becomes more integrated into the creative process, determining who holds the rights—whether the developer of the AI, the user, or the AI itself—poses significant legal challenges. This ambiguity could lead to disputes and a need for clearer legal frameworks.

2. Need for Legislative Reform:
- The current legislative landscape is not equipped to handle the rapid advancements in AI technology. This indicates a pressing need for lawmakers to update existing laws or create new regulations that specifically address the unique challenges posed by AI, ensuring that intellectual property rights are adequately protected while fostering innovation.

3. Limitations of AI:
- Despite its capabilities, AI still lacks the adaptability and nuanced understanding that human intelligence possesses. This limitation suggests that while AI can assist in generating ideas and solutions, it may not fully replace human creativity and decision-making, particularly in complex or unpredictable scenarios.

4. Challenges in Copyright:
- The potential for AI to generate content that closely resembles existing works raises significant copyright concerns. As AI tools become more prevalent, the risk of unintentional

plagiarism increases, necessitating a reevaluation of copyright laws to protect original creators while allowing for the use of AI.

5. Regulatory Ambiguities:
- The presence of ambiguities in existing IP laws can lead to confusion and inconsistency in how these laws are applied to AI-generated content. This highlights the need for clearer guidelines and definitions regarding what constitutes originality, ownership, and infringement in the context of AI.

6. Innovation vs. Protection:
- There is a delicate balance between encouraging innovation and protecting the rights of creators. As AI continues to evolve, finding this balance will be crucial to fostering an environment where both technological advancement and intellectual property rights can coexist harmoniously.

7. Ethical Considerations:
- The ethical implications of AI-generated content and its ownership raise important questions about accountability and responsibility. If an AI creates something that infringes on existing IP, who is liable? This question emphasizes the need for ethical guidelines alongside legal frameworks.

8. Future of IP in the AI Era:
- The discussions surrounding AI and IP rights suggest that we are at a pivotal moment in redefining how intellectual property is understood and enforced. As AI continues to develop, ongoing dialogue among stakeholders—including policymakers, legal experts, and technologists—will be essential to navigate these evolving challenges.

5. CONCLUSIONS

This study has explored the complex interplay between artificial intelligence (AI) and the realm of industrial property, particularly focusing on patents generated by AI systems. Through a mixed-methods approach that combined scientometric analysis and qualitative interviews, several significant findings and insights have emerged.

Key Findings

1. Emerging Research Landscape: The scientometric analysis revealed a rapidly growing body of literature on AI and patents, with a notable increase in publications over the past decade. Key authors and influential studies were identified, indicating a vibrant and evolving discourse in this field. This underscores the urgency for legal frameworks to adapt to technological advancements.(Picht and Thouvenin 2023),[11]
2. Diverse Perspectives on AI as an Inventor: The qualitative interviews with master's students highlighted a range of opinions regarding the status of AI as an inventor. While some participants expressed concerns about the implications of granting patent rights to AI-generated inventions—such as potential monopolistic practices—others recognized the necessity of providing legal protections to foster innovation and investment in AI technologies.(Picht and Thouvenin 2023),[11]
3. Legal and Ethical Implications: Participants raised important ethical considerations surrounding the accountability and responsibility for AI-generated inventions. The ambiguity in

current patent laws regarding AI's role as an inventor poses challenges for both innovators and legal practitioners, necessitating further dialogue and research in this area.(Kumar and Suthar 2024),[8]

4. Recommendations for Future Research: The findings suggest a need for interdisciplinary research that brings together legal scholars, technologists, and ethicists to develop comprehensive frameworks that address the unique challenges posed by AI in the patent system. Future studies could explore the long-term impacts of AI on innovation ecosystems and the role of policy in shaping these dynamics.(Gaon 2021b,[6]; Wan and Lu 2021,[21]; Afshar 2022b,[1]; Shemtov, 2024 [14])

The originality of this article lies in its comprehensive approach to understanding the implications of AI-generated patents through both scientometric and qualitative lenses. By integrating quantitative bibliometric data with qualitative insights from emerging professionals, this research provides a nuanced perspective that is often lacking in the existing literature.

Furthermore, this study contributes to the discourse on intellectual property by not only identifying key trends and authors but also by capturing the voices of future leaders in the field—those who will be directly impacted by the evolving landscape of AI and patent law. The findings highlight the need for an adaptive legal framework that reflects the realities of technological advancements, thereby paving the way for future research and policy discussions.

In conclusion, as AI continues to shape innovation and creativity, it is imperative for legal systems to evolve accordingly. This article serves as a foundational step in understanding the intersection of AI and industrial property, setting the stage for ongoing exploration and dialogue in this critical area of study.

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