International Journal of Graphic Design (IJGD)
Volume 4 No. 2 October 2026
E-ISSN: 2987-9434; P-ISSN : 2988-0343, Page 01-19
DOI: https://doi.org/10.51903/ijgd.v4i2.3807
Available online at: https://journal.stekom.ac.id/index.php/ijgd

Enhancing Intellectual Property Protection in Digital Graphic Design: A Conceptual Framework for Integrating Blockchain and Digital Rights Management Systems

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Abstract *This study addresses the increasing risk of intellectual property (IP) violations in the digital graphic design industry, driven by the ease of copying, modifying, and distributing digital content across online platforms. Traditional protection methods are no longer sufficient in the rapidly evolving digital environment. Therefore, the study aims to* develop a conceptual framework integrating *blockchain, digital watermarking, encryption, and Digital Rights Management (DRM) to enhance intellectual property protection in digital graphic design. The research adopts a descriptive–analytical approach supported by multiple case studies and a comparative analysis of recent academic literature and documented industrial applications. Selected case studies, including Adobe Content Authenticity and blockchain-based protection systems, were analyzed using predefined evaluation criteria to compare the capabilities of contemporary protection technologies within digital graphic design workflows. The comparative analysis indicates that multi-layered protection systems can enhance the security, authenticity, and traceability of digital design assets. Blockchain supports ownership verification through immutable records, while encryption, digital watermarking, and DRM provide complementary mechanisms for protecting digital content, improving transparency, and strengthening digital trust. The reviewed case studies demonstrate the practical applicability of integrated protection strategies within digital graphic design environments. The study also identifies key implementation challenges, including high operational costs, technical complexity, legal uncertainties, and limited user awareness. It concludes that sustainable intellectual property protection requires an integrated technological, legal, and educational approach, while the proposed conceptual framework provides a foundation for future empirical validation and practical implementation.*

Keywords: *Graphic Design; Intellectual Property Rights; Digital Design Protection; Blockchain Technology; Digital Rights Management (DRM)*

INTRODUCTION

The graphic design and digital creativity industry has undergone profound transformation over the past two decades due to advances in computing technologies, widespread adoption of digital tools, and the integration of artificial intelligence into creative production (Alkhateeb et al., 2026). Digital artworks can now be created, modified, and distributed globally within seconds, but this expansion has also increased intellectual property (IP) infringement risks, including unauthorized copying, redistribution, and manipulation (Ahmed et al., 2025; Hakim & Sholikhan, 2024; Ray Ku, 2002; Zeilinger, 2018). Although traditional mechanisms such as copyright registration and legal enforcement remain widely used, their effectiveness is increasingly challenged by the borderless and rapidly evolving digital environment. The problem addressed by this study is therefore the growing limitation of traditional IP protection mechanisms in

Received: June 2026; Revised: July 2026; Accepted: September 2026; Published: October 2026
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tracking, verifying, and preventing unauthorized use of digital graphic designs, particularly with the increasing prevalence of counterfeit digital designs and AI-generated content that complicates ownership and authenticity verification.

These challenges have created a need for advanced technological solutions that extend beyond conventional protection methods to include Digital Rights Management (DRM), blockchain, digital watermarking, and encryption. Such technologies can support ownership verification, traceability, transparency, and protection against unauthorized use. For graphic designers, their integration may provide secure mechanisms for protecting original design files, verifying authorship, preserving creative integrity, and supporting the commercialization of digital assets. Recent research emphasizes the limitations of traditional protection mechanisms and the need for technologically supported approaches to digital IP protection (WIPO, 2002). Blockchain, originally introduced through decentralized ledger technology (Nakamoto, 2008), has subsequently been applied to digital ownership verification through immutable ownership records and transparent transaction tracking (Al-Humaimeedy, 2025; Lu & Wu, 2024).

The integration of blockchain with other technologies has further expanded its potential. (Mastoi et al., 2025; Nguyen et al., 2026; Ragot et al., 2020) and (Dai & Wu, 2026) demonstrate the value of combining blockchain with machine learning for monitoring and verifying digital assets, while smart watermarking enables ownership information to be embedded within digital content and supports the tracking of unauthorized copies. Encryption also remains important for protecting digital files from unauthorized access, particularly when combined with blockchain-based verification systems (Russell & Norvig, 2003). Industrial applications provide further evidence of these approaches. (Adobe, 2025; Parsons, 2024) introduced Content Credentials through the Content Authenticity Initiative to embed verifiable metadata and ownership information in digital files.

Similarly, BlockGuard (Shang et al., 2025) and DataSafe (Xue et al., 2024) combine blockchain with watermarking and authentication techniques to improve digital asset integrity and traceability, while the Smart Registry-IP model demonstrates the potential of blockchain for digital registration and ownership verification (Al-Humaimeedy, 2025). Despite these developments, challenges related to scalability, legal recognition, cost, and user awareness remain. Effective IP protection requires not only technological innovation but also supportive legal frameworks and user education to promote adoption and sustainability (WifiTalents, 2025). Differences among national legal systems regarding the recognition of blockchain records and digital ownership evidence also affect the practical implementation of these technologies across jurisdictions.

Although previous research has examined blockchain and DRM-based IP protection, much of the literature focuses on technical implementation or specific industries such as music and digital media. Limited research has addressed the integration of blockchain, digital watermarking, encryption, and DRM within a unified conceptual framework specifically designed for digital graphic design. This study therefore proposes an integrated theoretical framework for strengthening IP protection in digital graphic design environments. The study contributes to digital IP protection by examining contemporary technological approaches and the integration of blockchain, DRM, digital watermarking, and encryption to reduce unauthorized use and strengthen the protection of digital designs. It also considers the economic and strategic importance of such technologies in reducing potential losses, enhancing digital asset value, and strengthening trust among designers, companies, and end users (Russell & Norvig, 2003). Specifically, the study aims to: analyze traditional methods of protecting digital designs and identify their limitations; examine the role of blockchain in enhancing IP protection; evaluate modern protection technologies, including blockchain, digital watermarking, encryption, and DRM; and review and compare national and international legal frameworks and identify associated challenges. The remainder of the paper presents the literature review and theoretical framework, followed by the technological approaches and proposed framework, discussion, conclusions, and recommendations.

LITERATURE REVIEW

Recent research has increasingly examined the challenges of protecting intellectual property (IP) in digital environments, particularly in creative industries such as graphic design. Traditional protection mechanisms face limitations in addressing the rapid dissemination and unauthorized reproduction of digital content, creating a need for advanced technological solutions (WIPO, 2024a). Blockchain has emerged as a foundational technology for digital ownership verification. (Nakamoto, 2008) introduced decentralized ledger systems, which have subsequently been applied to digital asset protection through immutable ownership records and transparent transaction tracking (Alkhateeb et al., 2026; Lu & Wu, 2024). Blockchain has also been integrated with artificial intelligence and machine learning to improve the verification and monitoring of digital assets, particularly in collaborative design environments (Myeong & Ram, 2025; Nguyen et al., 2026; Ragot et al., 2020).

Recent studies have further explored integrated protection approaches combining blockchain with digital watermarking and encryption. Smart watermarking enables ownership information to be embedded within digital content while supporting the tracking of unauthorized copies (LiuXinyun et al., 2025; Nguyen et al., 2026; Rai & Kesarwani, 2026; Shang et al., 2025),

whereas encryption protects digital files against unauthorized access, particularly when combined with blockchain-based verification (Russell & Norvig, 2003). Industry applications provide practical evidence of these approaches. (Adobe, 2025; Parsons, 2024) introduced Content Credentials to embed verifiable metadata and ownership information within digital files, combining identity verification and content protection. Similarly, BlockGuard (Shang et al., 2025) and DataSafe (Xue et al., 2024) demonstrate the integration of blockchain with watermarking and authentication techniques to improve digital asset integrity and traceability. The Smart Registry-IP model further highlights the potential of blockchain for simplifying digital registration and enhancing ownership verification (MDPI, 2024).

Despite these technological advances, scalability, legal recognition, cost, and user awareness remain significant challenges. Effective IP protection requires technological innovation together with supportive legal frameworks and user education to promote adoption and sustainability (WifiTalents, 2025). Differences among national legal systems concerning the recognition of blockchain records and digital ownership evidence also affect implementation across jurisdictions. Although previous studies have extensively examined blockchain and DRM systems for IP protection, much of this research focuses on technical implementation or specific industries such as music and digital media. Limited research has addressed the integration of blockchain, digital watermarking, encryption, and DRM within a unified conceptual framework specifically tailored to digital graphic design. Therefore, this study addresses this gap by proposing an integrated theoretical framework that combines these technologies to strengthen IP protection in digital graphic design environments.

Concept of Intellectual Property

Intellectual property is a set of rights protecting human creativity, inventions, artistic works, and designs, enabling owners to control their use and obtain economic benefits (WIPO, 2024b). It is also fundamental to promoting innovation and ensuring appropriate recognition and economic benefits for creators (Alkhateeb et al., 2026).

Traditional Methods of Protecting Designs

1. **Registration with Intellectual Property Offices:** Registration requires design documentation, descriptions, and drawings and protects against imitation within the relevant jurisdiction (WIPO, 2024a).
2. **Proving the Date of Creation:** Paper copies, emails, and work documents can provide evidence of the date of creation.

3. **Legal Licenses:** Licenses grant specified users rights to use designs under defined conditions and penalties for violations.

Blockchain Technology in Design Protection

Blockchain is a distributed and encrypted digital ledger that permanently records data and is characterized by transparency, decentralization, and immutability (Nakamoto, 2008).

Blockchain Applications

Blockchain can be used to register digital designs, document ownership through Non-Fungible Tokens (NFTs), and track design transactions. NFTs provide unique evidence of ownership, while systems such as Smart Registry-IP support the registration and trading of designs (Al-Humaimeedy, 2025). Integrating blockchain with traditional protection methods can provide comprehensive, traceable, and secure protection for digital designs. The evolution of IP protection throughout the digital graphic design process is illustrated in Figure 1, from creation and documentation to watermarking, encryption, and Digital Rights Management (DRM), and ultimately to blockchain, NFTs, and smart contracts during distribution and trading.

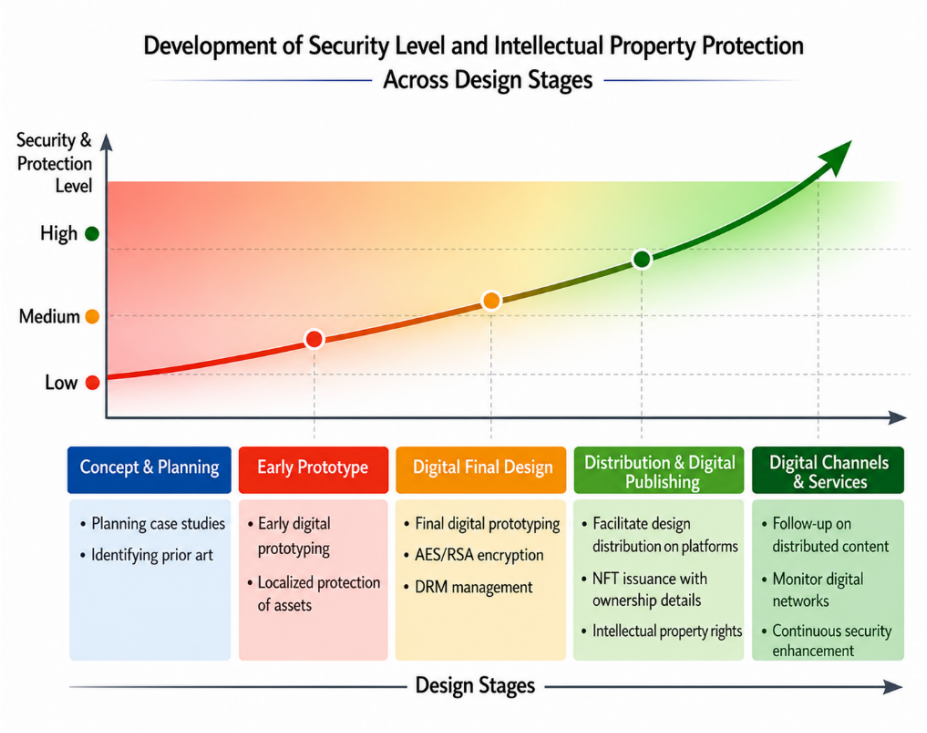


Figure 1. Evolution of Intellectual Property Protection Throughout the Digital Graphic Design Process.

Smart Watermarking

(Mekhfioui et al., 2025 and Rai & Kesarwani, 2026), supporting authenticity verification and tracking unauthorized use. Its integration with blockchain and DRM provides a broader protection framework (Nguyen et al., 2026), particularly for artwork, branding, illustrations, packaging, advertising graphics, and other digital assets.

Encryption

Encryption protects digital files from unauthorized access through algorithms such as AES and RSA. Smart encryption can prevent unauthorized modification or copying and strengthen information security (Russell & Norvig, 2003).

Digital Rights Management (DRM)

DRM systems control access to digital files and define conditions for copying, printing, and sharing. Combined with watermarking and encryption, DRM can provide comprehensive protection and reduce digital infringement (WifiTalents, 2025). For designers and agencies, DRM also supports controlled distribution of editable files, commercial licensing, and prevention of unauthorized reuse.

Encryption-Based Protection

Smart encryption uses AES and RSA to protect digital design files. Their combination as Hybrid Encryption is used in HTTPS, cloud storage, and digital property protection systems and can be integrated with blockchain to track modifications to original designs. Figure 2 illustrates the basic workflow, showing how encryption protects files before publication and restricts access to authorized users.

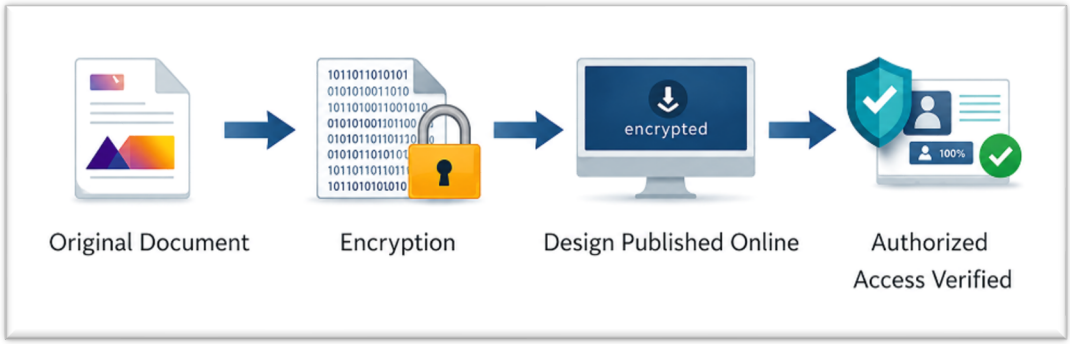


Figure 2. Smart encryption mechanism for digital designs.

Digital Rights Management (DRM) based on blockchain

DRM and encryption provide complementary mechanisms for protecting digital graphic assets, as illustrated in Figure 3. DRM controls how digital content can be used after authorized access, including restrictions on copying, printing, devices, duration, or internet-based license

verification. Integration with blockchain can identify authorized users and document usage, while systems such as Secure Rights combine watermarking and blockchain for enhanced protection. Recent industry reports indicate approximately 40% lower copyright infringement and an estimated 20% increase in revenue associated with blockchain-based protection (WifiTalents, 2025). The main technologies reviewed are summarized in Table 1. content before and after authorized access.

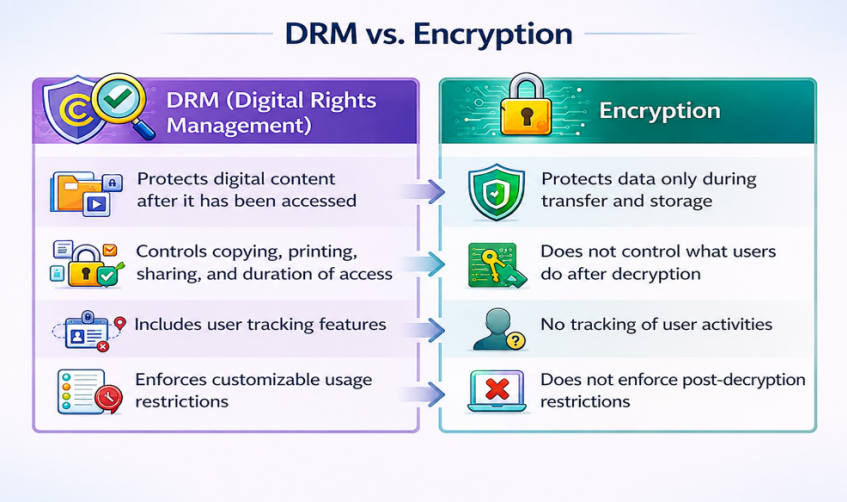


Figure 3. Digital Rights Management (DRM) systems represent an advanced layer of protection that goes beyond traditional encryption.

The comparative adoption index reflects relative technology adoption reported in recent industry statistics, while infringement reduction and additional revenue values are based on the cited source rather than primary empirical findings. Recent literature and documented industrial cases provide the basis for the comparative overview in Figure 4.

Table 1. Selected Industry Indicators Related to the Adoption and Impact of Digital Design Protection Technologies - Source: Adapted from (WifiTalents, 2025)

Protection Technology	Comparative Adoption Index	Reported Reduction in Infringement (%)	Reported Additional Revenue (%) |
Watermarking	25	25	10
Blockchain and NFTs	45	40	20
DRM	30	35	15

Figure 4 compares the relative capabilities of modern technologies for protecting digital graphic designs, based on recent literature, documented case studies, and industrial reports, including Adobe (Adobe, 2025; Parsons, 2024), (WifiTalents, 2025), (Lu & Wu, 2024), (Shang et al., 2025), and Xue et al. (2024). The indices represent conceptual comparisons rather than primary empirical measurements. Blockchain and NFTs provide higher protection rates than the other reviewed methods, while digital signatures and artificial intelligence provide moderate protection and traditional encryption shows a lower comparative rate. Table 2 compares legal

frameworks across selected jurisdictions, focusing on recognition of blockchain-based ownership records and digital evidence.

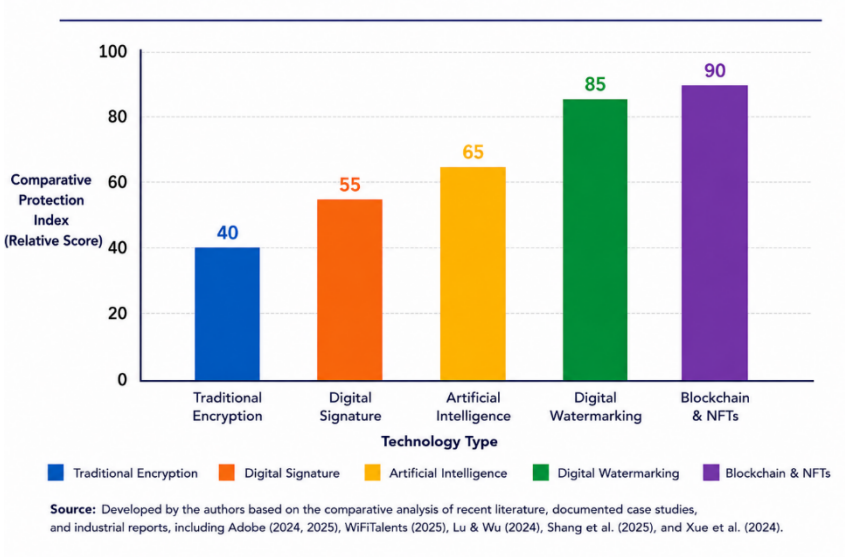


Figure 4. Comparative Assessment of Modern Technologies for Digital Design Protection Based on Recent Literature and Industrial Case Studies

Table 2. Comparative Legal Recognition of Blockchain-Based Intellectual Property Protection Frameworks in Selected Jurisdictions

Country	**Primary Legal Framework**	**Recognition of Digital Ownership Evidence**	**Readiness for Blockchain, NFTs and DRM Integration**
Egypt	Law No. 82 of 2002	Legal protection relies primarily on conventional copyright registration; blockchain evidence is not yet specifically recognized.	Moderate readiness, with opportunities for legislative modernization and digital transformation.
Saudi Arabia	SAIP, Copyright Law, Industrial Designs Law	Copyright registration and digital enforcement mechanisms are established; blockchain records are not yet explicitly regulated but can support ownership documentation.	High potential for future blockchain integration through ongoing digital transformation initiatives.
European Union	Community Design Regulation, EUIPO	Strong acceptance of electronic filing and digital evidence, providing a favorable legal environment for emerging blockchain applications.	High readiness for blockchain-supported intellectual property management.
United States	DMCA, U.S. Copyright Law	Copyright registration remains the primary legal evidence; blockchain timestamps may provide supporting evidence but are not independently regulated under federal copyright law.	High practical adoption potential for blockchain-supported ownership verification.
Japan	Design Act, JPO Regulations	Advanced digital filing systems and protection of GUI designs create a supportive environment for integrating blockchain and AI technologies.	High readiness supported by advanced digital intellectual property infrastructure.

(EUIPO, 2025; JPO, 2024; SAIP, 2025; US Congress, 1998; WIPO, 2002).

The comparison shows that all examined jurisdictions provide IP protection mechanisms, but recognition of blockchain-based ownership records and related technologies varies considerably. Developed jurisdictions generally show greater readiness to accommodate emerging digital evidence and electronic registration, while emerging economies continue developing comprehensive frameworks. Effective IP protection therefore requires alignment between technological innovation and evolving legal and regulatory frameworks.

Application of Emerging Protection Technologies in Digital Graphic Design Workflows

Graphic design projects typically involve creation, revision, collaboration, client approval, publication, and long-term distribution. Throughout these stages, source files, compositions, illustrations, branding materials, packaging designs, and digital publications remain vulnerable to unauthorized copying, modification, and redistribution. Blockchain, digital watermarking, encryption, and DRM can support ownership verification, revision tracking, file protection, access control, and lifecycle documentation. Consequently, IP protection in graphic design should be treated as an integrated process embedded within the creative workflow rather than solely as a legal procedure applied after publication.

METHODS

This study adopts a descriptive-analytical approach to examine contemporary technological solutions for protecting intellectual property rights in digital graphic design. A multiple-case study strategy was also employed to compare protection systems integrating blockchain, digital watermarking, encryption, and Digital Rights Management (DRM). This design supports the systematic examination of existing literature, industrial applications, and technological developments and is appropriate for synthesizing knowledge, comparing practical implementations, and developing an integrated conceptual framework rather than statistically testing predefined hypotheses.

Case Selection Criteria

Six representative case studies were purposively selected according to four criteria: (1) practical implementation in digital creative environments, (2) integration of advanced IP protection technologies, (3) availability of sufficient technical and academic documentation, and (4) relevance to digital graphic design workflows. The selected cases are Adobe Content Authenticity Initiative, Smart Registry-IP, BlockGuard, DataSafe, the Blockchain-Based Framework for Design Protection, and the Intellectual Property Lifecycle Management Framework. Together, they represent approaches combining blockchain with digital watermarking, DRM, smart contracts, artificial intelligence, and digital authentication mechanisms.

Data Sources

The study relies exclusively on secondary qualitative data from authoritative sources, including peer-reviewed journal articles published between 2020 and 2025; official reports and technical documentation from Adobe, WIPO, EUIPO, SAIP, and JPO; corporate publications describing commercial digital IP protection systems; published blockchain-based IP case studies; and international legislation and regulatory documents concerning copyright, digital IP, and digital ownership rights. No primary data were collected; the analysis is based on synthesis and critical comparison of documented secondary evidence.

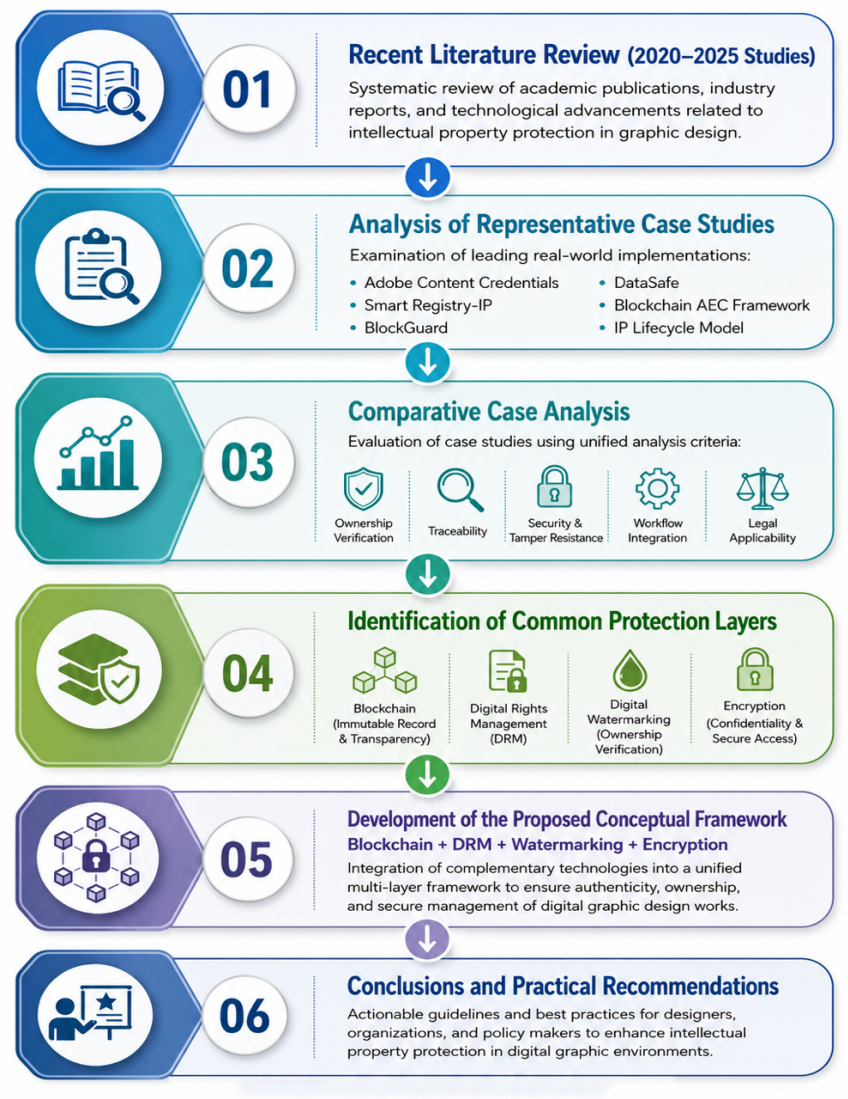


Figure 5. Methodological Framework for Developing the Proposed Conceptual Framework

Comparative Analysis Procedure

The selected cases were analyzed using a structured comparative framework based on common criteria derived from the literature. These included ownership verification, digital asset traceability, protection against tampering and unauthorized modification, integration with digital

graphic design workflows, compatibility with DRM and digital watermarking, scalability and practical applicability, and legal enforceability and ownership documentation. The analysis identified common strengths, limitations, and complementary functions and supported development of the proposed conceptual framework.

Conceptual Framework Development

The framework was developed through five stages: reviewing recent academic literature; identifying emerging protection technologies relevant to graphic design; analyzing representative case studies; comparing the technical capabilities and complementary functions of the selected systems; and integrating these technologies into a unified conceptual framework. This process extends beyond descriptive literature review toward an integrated framework supporting future implementation and multi-layered protection strategies. Figure 5 summarizes the methodological workflow adopted in the study.

Selected Case Studies:

Digital Design Platforms

Recent digital design platforms increasingly use blockchain and Non-Fungible Tokens (NFTs) with smart watermarking to protect digital assets. These systems embed creator identity, digital signatures, metadata, and watermarking information to strengthen authorship verification, traceability, and authenticity. A notable example is Adobe's Content Authenticity Initiative, which uses Content Credentials to enhance transparency and ownership verification in digital environments (Adobe, 2025).

Adobe Content Authenticity Application for Protecting Ownership Rights

Adobe Content Authenticity enables creators to embed Content Credentials in images, videos, and audio as part of the Content Authenticity Initiative (CAI) (Adobe, 2025). Invisible watermarks and secure metadata remain associated with files shared online, allowing creators to prove ownership, digitally sign works, and establish attribution. The system also supports verified identity through platforms such as LinkedIn and Behance, strengthening authorship verification and reducing unauthorized reuse or manipulation (Adobe, 2025).

Comparative Analysis of Protection Systems

Smart Registry-IP System for Digital Property Protection

Smart Registry-IP represents a blockchain-based model for protecting digital IP. Introduced in 2025, it integrates blockchain and artificial intelligence to register digital assets, ownership rights, and licensing agreements in a decentralized environment. Smart contracts securely record and verify ownership data, improving record integrity, licensing efficiency, transaction security, and verification speed compared with traditional method (Nguyen et al.,

2026). These capabilities support the proposed framework by demonstrating the value of integrating multiple protection technologies.

Emerging Blockchain-Based Protection Systems

Block Guard System: An Advanced Approach to Digital Copyright Integrity

Block Guard integrates blockchain, digital watermarking, smart contracts, and Non-Fungible Tokens (NFTs) to protect digital copyright. Evaluated in 2025 against traditional protection methods, the system seeks to reduce forgery and unauthorized distribution while improving ownership verification and lifecycle traceability (Shang et al., 2025).

DataSafe System: Copyright Protection Using Uncopyable Watermarking and Blockchain

DataSafe combines PUF-based watermarking with blockchain. Its functional prototype, introduced in 2024, generates a unique hardware-based fingerprint for each digital asset and links it to a blockchain record, preventing duplication or manipulation of ownership information. This integration strengthens security and authenticity verification for multimedia and digital design assets (LiuXinyun et al., 2025).

Blockchain-Based Framework for Intellectual Property Protection in Design Environments

A 2024 framework published in Computers in Industry applies blockchain to protect IP in architecture and construction by permanently recording ownership, modifications, updates, and transactions. It supports continuous tracking in collaborative environments and strengthens trust while reducing ownership and authorship disputes (Lu & Wu, 2024). Although developed for architecture and construction, its principles—secure ownership documentation, modification tracking, and collaborative workflow management—are applicable to digital graphic design and demonstrate the broader potential of blockchain-based IP protection.

Managing the Lifecycle of Intellectual Property Using Blockchain and Artificial Intelligence

A 2020 framework integrates blockchain and artificial intelligence to manage digital IP throughout its lifecycle, from creation and registration to distribution and reuse. Blockchain records ownership and transactions immutably, while machine learning analyzes and compares digital content to support automated ownership verification, similarity detection, and infringement identification. The framework provides a foundation for contemporary systems combining blockchain, AI, watermarking, and DRM and supports the development of intelligent, adaptive, and scalable protection for digital design assets (Haeri et al., 2020).

RESULTS AND DISCUSSION

The comparative figures and quantitative values presented in this section are derived from the synthesis of evidence obtained through the comparative analysis of recent literature, documented case studies, and industrial reports. The reported numerical values should therefore

be interpreted as comparative indices illustrating the relative characteristics, adoption trends, and effectiveness of the reviewed digital protection technologies within the proposed analytical framework. This presentation is consistent with the descriptive–analytical and conceptual nature of the present study. The comparative adoption of contemporary digital protection technologies reported in the reviewed literature is presented in Figure 6.

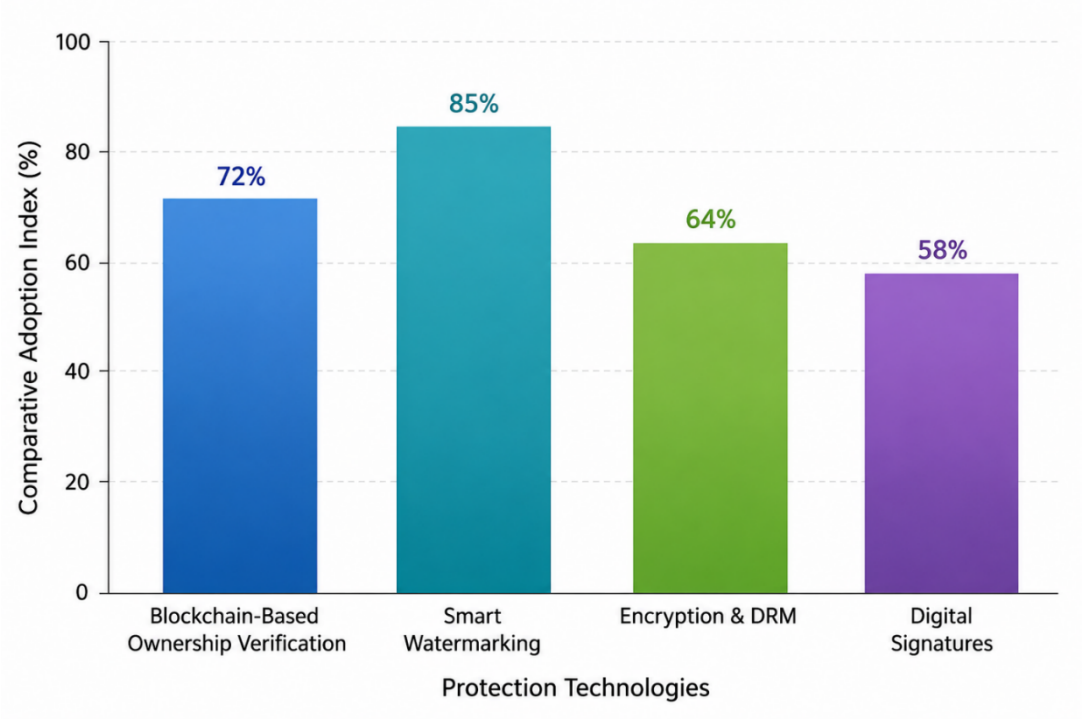


Figure 6. Comparative Adoption of Digital Design Protection Technologies Based on Recent Literature and Industrial Case Studies.

Figure 6 illustrates the level of adoption of digital intellectual property protection technologies within the design and publishing sector. The data indicate that digital watermarking ranks as the most widely adopted technology, with a prevalence rate of approximately 85%. This high adoption level can be attributed to its ease of integration into digital design files without affecting visual quality, as well as its effectiveness in tracking unauthorized copies. Blockchain technology follows with an adoption rate of 72%, reflecting a growing trend toward decentralized systems for verifying ownership and ensuring the immutability of digital records. This indicates an increasing awareness among institutions of the importance of secure and transparent ownership documentation.

Encryption systems and Digital Rights Management (DRM) technologies show moderate adoption levels, each at approximately 64%, suggesting that they are commonly utilized as complementary security layers rather than standalone solutions. Similarly, digital signatures record a slightly lower adoption rate of 58%, indicating their more specialized use in

authentication and verification processes. Overall, the findings suggest that organizations increasingly rely on the integration of multiple technologies to establish multi-layered protection frameworks. This approach enhances security, improves traceability, and reduces the risks associated with intellectual property violations in digital environments. These findings support the study's argument that no single technology is sufficient on its own, reinforcing the need for integrated protection frameworks.The integration of these technologies can substantially improve the protection of commercial graphic design projects throughout their lifecycle. The major implementation challenges identified through the comparative analysis are summarized in Figure 7.

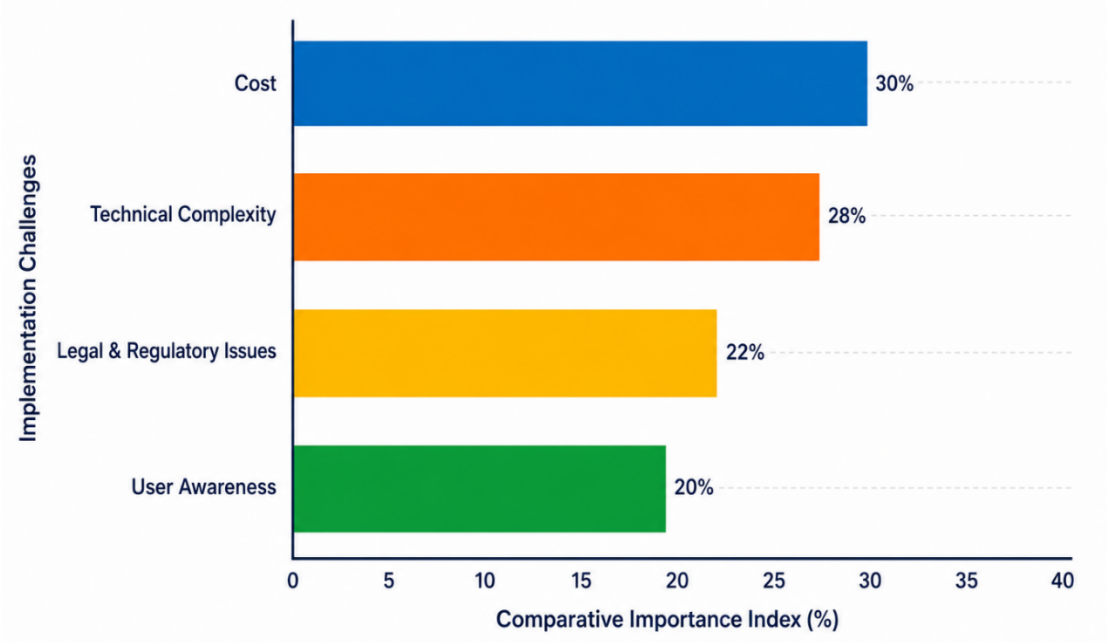


Figure 7. Comparative Distribution of Key Challenges in Implementing Digital Graphic Design Protection Technologies Based on Reviewed Literature and Industrial Reports.

Figure 7 summarizes the major implementation challenges identified through the comparative analysis of the reviewed literature and documented industrial reports. The comparative distribution indicates that high operational costs represent the most prominent challenge (approximately 30%), including expenditures associated with technical infrastructure, software licensing, and system maintenance. Technical complexity follows (approximately 28%), reflecting the need for specialized expertise and advanced implementation capabilities. Legal and regulatory challenges account for approximately 22%, highlighting variations in the legal recognition of digital ownership and blockchain-based evidence across different jurisdictions. User awareness represents approximately 20%, emphasizing the importance of education and professional training for the effective adoption of digital protection technologies.

Although these comparative values do not represent primary empirical measurements, they illustrate the relative prominence of the implementation challenges consistently reported across the reviewed literature. Collectively, these findings reinforce the need for integrated protection frameworks that combine technological innovation, legal support, and user awareness to enhance intellectual property protection in digital graphic design environments. Figure 8 illustrates the comparative temporal trend reported in the reviewed literature and industrial reports regarding the reduction of digital graphic design infringement following the adoption of advanced protection technologies.

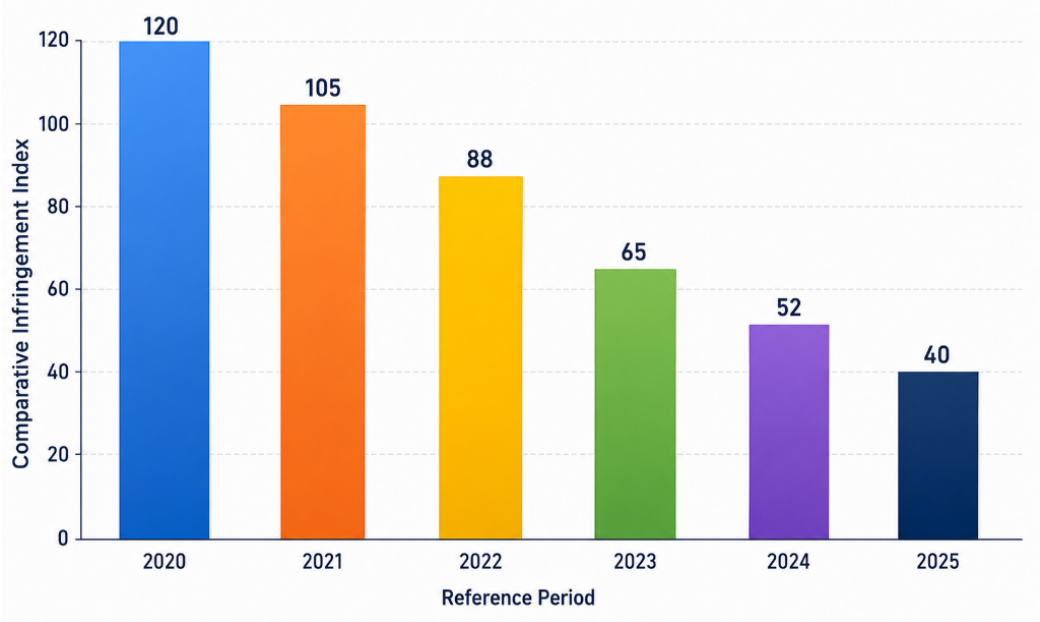


Figure 8. Comparative Temporal Trend in Digital Graphic Design Infringement Reduction (2020–2025) Based on Published Literature and Industrial Reports.

The synthesized comparative indices indicate a steady downward trend, decreasing from approximately 120 in the 2020 reference period to around 40 in the 2025 reference period. Although these values do not represent primary empirical observations, they illustrate the overall pattern consistently reported across the reviewed studies and documented industrial applications. The reviewed evidence further suggests that integrated protection strategies combining blockchain, digital watermarking, encryption, and Digital Rights Management (DRM) provide complementary mechanisms for improving ownership verification, traceability, transparency, and the overall reliability of intellectual property protection within digital graphic design environments. The relationships between the selected digital protection technologies and their reported protection outcomes are summarized in Table 3.

Table 3. Comparative Analysis of Selected Digital Protection Systems for Graphic Design Intellectual Property and Their Key Protection Outcomes.

The study	Main Technology	Year of Application	Key Results
SmartRegistry-IP	Blockchain & Smart Contracts	2025	- Accelerating the registration of rights and reducing intermediary intervention - A decentralized system for securely registering and updating property rights. - Reducing the risk of data loss or manipulation after registration. - Accelerating licensing procedures without the need for costly legal intermediaries.
BlockGuard	Blockchain + Watermarking + NFTs	2025	- Improving integrity and reducing piracy - Enhancing the integrity of digital rights management and reducing opportunities for manipulation. - Facilitating the management of copyright disputes through immutable records on the blockchain. - Documenting digital ownership in a decentralized manner.
DataSafe	PUF Watermarking + Blockchain	2024	- Proving ownership using non-reproducible fingerprints - The ability to prove ownership of digital designs by verifying the fingerprint on the blockchain. - Strengthening rights protection with a dual mechanism: secure watermarking + decentralized ledger. - Improving the tracking of property transfer between the two parties with high accuracy.
AEC Framework	Blockchain for design rights	2024	- Tracking design rights in a collaborative environment - Increasing the ability to track changes in design rights throughout the development stages. - Providing a decentralized record that reduces ownership disputes among partners. - Enabling tiered access rights for all relevant parties.
IP Lifecycle Model	Blockchain + ML	2020	- Automatic comparison and documentation of the lifecycle - Facilitating the assessment of ownership overlaps and infringements in the context of digital designs. - Integrating machine learning to identify similarities and report violations. - Improving decision-making accuracy in case of disputes.

Table 3 illustrates the relationships between the selected digital protection technologies and their reported protection outcomes. The comparison indicates that each technology addresses different aspects of intellectual property protection. While blockchain primarily enhances ownership verification and traceability, watermarking strengthens content authentication, DRM regulates content usage, and artificial intelligence supports automated monitoring and

infringement detection. Collectively, these technologies provide complementary capabilities that support the development of integrated protection frameworks for digital graphic design.

Limitations

The scope of this study is limited to the analysis of published technical systems, industrial applications, and documented case studies related to intellectual property protection in digital graphic design. It does not include primary empirical data collection, experimental validation, pilot implementation, or questionnaire-based statistical analysis. Accordingly, the proposed framework should be interpreted as a conceptual model developed through the comparative analysis and synthesis of existing technologies, documented case studies, and recent literature. Future research may validate and refine the proposed framework through pilot implementation and empirical evaluation within professional graphic design organizations.

Future Research Directions

Future research should empirically validate and refine the proposed framework across different digital graphic design environments. Further studies may examine the practical integration of blockchain and NFTs for ownership verification, strengthen the combined use of watermarking and encryption, and investigate standardized legal mechanisms for recognizing and enforcing digital ownership records. Research should also address designers' awareness and effective use of digital protection technologies while continuously monitoring technological, legal, and international developments. Such investigations can support the development of more comprehensive, adaptive, and practically applicable intellectual property protection systems for digital design ecosystems.

CONCLUSION

This study examined the potential of integrating blockchain, digital watermarking, encryption, and Digital Rights Management (DRM) to strengthen intellectual property protection in digital graphic design. The findings indicate that traditional protection mechanisms alone may be insufficient for the complexity of the digital environment, while multi-layered protection can enhance security, traceability, authenticity, and controlled use of digital assets. Blockchain supports transparent and tamper-resistant ownership verification, while watermarking, encryption, and DRM provide complementary protection against unauthorized access, duplication, and use. The analyzed cases, including Adobe Content Credentials, BlockGuard, DataSafe, and Smart Registry-IP, demonstrate the practical applicability and complementary roles of these technologies. The proposed framework therefore supports an integrated approach to protecting graphic design assets throughout their lifecycle and provides practical value for graphic

designers, creative agencies, publishers, and digital content producers. Rather than relying on a single technology, the framework emphasizes the complementary integration of technological, legal, and regulatory mechanisms to strengthen intellectual property protection in digital graphic design environments.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article

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