Blockchain-Based Copyright Protection System for Digital Content Creators in Rwanda

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Abstract

This research paper explores the application of blockchain technology in protecting the copyright of digital content creators in Rwanda. The study examines current challenges faced by creators in registering and enforcing copyrights and proposes a decentralized system using blockchain to provide transparent, tamper-proof, and verifiable copyright records. Using Ethereum smart contracts and decentralized storage, the proposed system ensures content ownership authentication, traceability, and enforcement mechanisms. It highlights the growing creative economy in Rwanda and the need for modern solutions to safeguard intellectual property. Through a combination of technical implementation and stakeholder feedback, the system demonstrates potential to revolutionize digital rights management for Rwandan artists, musicians, writers, and other content creators. The study examines socio-economic implications for Rwanda, emphasizing how such a system could reduce piracy, enhance digital trust, and foster creative entrepreneurship. By aligning blockchain solutions with existing IP law reforms and educational initiatives, this work lays a foundation for digital content protection policies that could be adopted throughout East Africa. It also includes a flow chart illustrating the process, a prototype design, and policy recommendations, with references to support the analysis.

Keywords: *Blockchain, Copyright, Intellectual Property, Rwanda, Digital Content, Decentralization, Smart Contracts, IPFS*

1. Introduction

Digital content creators in Rwanda face growing concerns over copyright infringement due to the ease of copying, sharing, and distributing content online. Inappropriate usage of artistic creations has increased with the growth of social networking sites and online markets. Creators are frequently deterred from seeking legal protection by the lengthy, costly, and manipulable nature of traditional copyright registration procedures. Furthermore, authors find it challenging to establish ownership and seek legal redress due to the absence of centralized enforcement procedures. Blockchain technology, with its decentralized and unchangeable ledger, presents a viable substitute for safe digital rights management by offering a quick, easy, and verifiable method of registering and monitoring content ownership.

1.1 Case study

In 2024, a Rwandan photographer named Eric Mukiza had his photographs published and shared widely without his permission after uploading them to social media. The lack of a formal copyright registration made it challenging to demonstrate legal ownership in court, even when original files and timestamps were shown. Eric registered a new photo series using the prototype blockchain system, anchoring metadata on Ethereum and saving hashes of his photos on IPFS. He had a publicly available, provable, and unchangeable proof of ownership in a matter of minutes. In order to prevent a drawn-out legal battle, Eric was able to provide cryptographic evidence of original authorship when another party attempted to claim the content. This was accepted during mediation.

1.2 Technical explanation

The proposed system uses the Ethereum blockchain to store smart contracts that manage copyright metadata. When a user submits digital content, the file is hashed (using SHA-256), and this hash is stored on IPFS, a decentralized file storage network. The resulting IPFS hash and creator metadata (name, timestamp, content type) are stored in a smart contract. This procedure guarantees that the original material cannot be altered or copied covertly. Verification is performed by matching the hash of disputed content with the original stored hash. Without the need for complex technical knowledge, creators may quickly register, confirm, and exchange ownership details via a decentralized user interface.

2. Problem statement

Digital content producers in Rwanda do not have access to an effective, safe, and affordable copyright protection mechanism. Current methods are centralized, frequently unavailable to small-scale creators, and lack real-time verification.

Digital content creators in Rwanda struggle to protect their intellectual property due to several interlinked issues: weak enforcement of existing IP laws, rampant piracy facilitated by the ease of digital duplication and sharing, and inefficient or inaccessible copyright registration processes. Under-registration of creative works results from the fact that many authors lack the financial means or technical know-how to deal with formal legal systems. In addition, the lack of unchangeable evidence or standardized paperwork makes authorship and ownership conflicts challenging to settle.

The existing IP management solutions' insufficient technological integration makes these issues worse. Thus, it is imperative to have a strong, safe, and easy-to-use copyright protection system that assures fair pay for content producers through transparent, decentralized processes, promotes automated rights management, and ensures accurate ownership verification.

3. Literature Review

Copyright and Intellectual Property in Rwanda. Rwanda's current copyright laws provide protection but rely heavily on manual registration and enforcement processes. There is increasing agreement on the revolutionary potential of blockchain technology, according to the literature on its uses in intellectual property (IP) management. Blockchain offers special benefits for recording and confirming digital ownership because of its immutable, decentralized, and transparent nature. Scholars like De Filippi and Wright (2018) highlight how blockchain can upend established intellectual property frameworks by offering automated, impenetrable tools for rights registration and enforcement. Similarly, O'Dair & Beaven (2017) investigate how blockchain might promote stakeholder trust and open up new models for smart

contract-based licensing and pay. Such ideas are particularly interesting in Rwanda, where structural inefficiencies in digital rights enforcement are a problem. Blockchain has the potential to be a fundamental instrument for updating intellectual property infrastructure, increasing its dependability and accessibility for content producers.

Blockchain Technology Overview: Blockchain is a distributed ledger that allows data to be recorded immutably. Features include transparency, decentralization, and cryptographic security.

4. Methodology

The study uses a qualitative research technique to investigate the expectations, experiences, and perceptions of important players in Rwandan intellectual property protection and digital content development. A purposive sample of 20 participants, including digital content creators (such as musicians, filmmakers, and software developers), IP law specialists, Rwanda Development Board (RDB) representatives, and blockchain technology specialists, participated in semi-structured interviews to gather primary data. The purpose of these interviews was to obtain detailed information on the difficulties facing the current copyright framework and how blockchain technology can help address those difficulties.

The study carried out document analysis of current policy frameworks, including international treaties like the Berne Convention, Rwanda's copyright laws, and ICT regulations. Academic publications, white papers, and reports from international organizations such as UNESCO and WIPO were examples of secondary sources.

1. Tools and Technologies
- Ethereum blockchain
- IPFS (InterPlanetary File System)
- Smart contracts (Solidity)

5. System Architecture

The system leverages the Ethereum blockchain to facilitate secure and automated copyright management for digital content creators in Rwanda. The framework integrates multiple decentralized technologies to offer a comprehensive solution. Important elements consist of:

- **Digital Registration Portal**: An easy-to-use online platform that allows content producers to register ownership, submit their work, and start licensing contracts.

- **Smart Contracts**: Deployed on Ethereum, these contracts automate the enforcement of licensing terms and royalty distribution based on predefined rules.

- **IPFS (InterPlanetary File System)**: Used for decentralized storage of digital content. Only content hashes are stored on the blockchain to ensure scalability and efficiency.

- **Public Ledger**: Maintains a tamper-proof and transparent record of content ownership, licensing history, and royalty transactions.

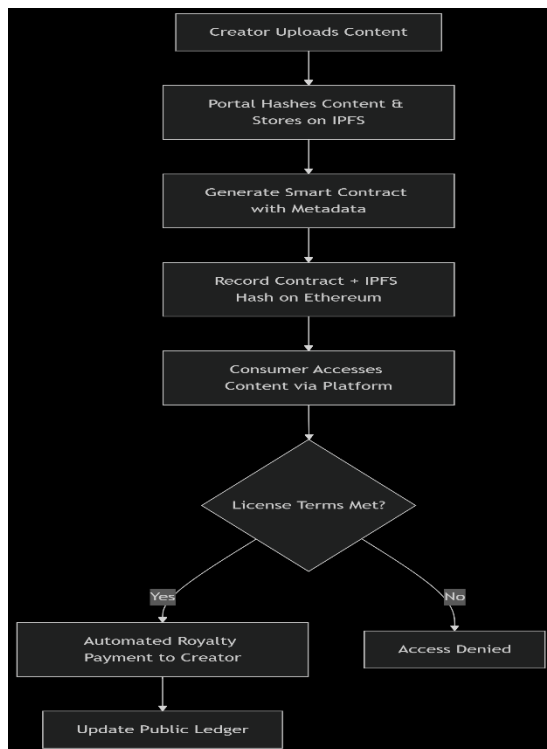### 5.1. The system workflow can be summarized as follows:

Figure 1: System workflow

   a. **Creator Uploads Content**:

      o A creator logs into the portal and uploads a digital file (e.g., image, music, document).

   b. **IPFS Storage & Hashing**:

      a. The portal generates a cryptographic hash (CID) of the content and pins it to IPFS for decentralized storage.

      b. Only the CID (not the full file) is sent to the blockchain.

   c. **Smart Contract Generation**:

      a. A smart contract is auto-generated with:

         i. **Metadata**: Title, description, creation date.

         ii. **Ownership**: Creator's wallet address.

         iii. **Licensing**: Pricing, allowed uses, royalty %.

   d. **Ethereum Blockchain Recording**:

      a. The smart contract and IPFS CID are written to Ethereum as an immutable record.

      b. This creates a tamper-proof proof of ownership and licensing terms.

   e. **Consumer Interaction**:

      a. A consumer (licensee) accesses the content through the platform.

      b. The smart contract checks:

      i. Payment for licensing (e.g., ETH/USDC).

     ii. Compliance with terms (e.g., no commercial use).

  f. **Automated Royalty Enforcement**:

     a. If terms are met:

        i. Payment is split automatically (e.g., 90% to creator, 10% to platform).

       ii. Transaction is logged on the public ledger.

     b. If terms are violated:

        i. Access is denied (e.g., via NFT-gated content).

6. Implementation and Use Case

Scenario A Rwandan musician uploads a song to IPFS, receives a hash, and registers it on Ethereum using the dApp. A smart contract governs licensing terms. Any party interested in using the song pays through a crypto gateway and receives usage rights. All transactions are logged immutably on the blockchain, enabling a verifiable audit trail for licensing and royalty payments. The creator receives automatic micropayments upon content access, reducing reliance on intermediaries.

Additionally, users can view licensing history, verify authenticity, and dispute ownership claims through a decentralized verification interface. This enhances transparency and discourages piracy or unauthorized distribution.

6.1. Benefits

- Immutable proof of ownership
- Easy licensing and monetization
- Decentralized access
- Low operational cost
- Real-time royalty distribution
- Increased trust through transparency
- Global accessibility for Rwandan creatives

6.2. Limitations

- Requires internet access and technical knowledge
- Regulatory gaps in recognizing blockchain-based IP claims
- Volatility of cryptocurrency payments
- User resistance due to unfamiliarity with blockchain interfaces
- Challenges in integrating blockchain data with conventional legal evidence systems

7. Conclusion

This study presents a blockchain-based system as a viable solution to copyright challenges faced by digital content creators in Rwanda. By leveraging immutable ledgers, decentralized access, and smart contracts, creators can protect their work more efficiently and transparently. The implementation of such a system allows for real-time copyright registration, automated

licensing agreements, and royalty distribution mechanisms that ensure fair compensation for creators.

The integration of decentralized technologies reduces dependency on centralized institutions that often fail to serve creators equitably, especially in developing contexts. This model encourages innovation and trust in the digital ecosystem, promoting local and international collaborations.

While legal and infrastructural challenges exist—such as the need for digital literacy, reliable internet connectivity, and legal recognition of blockchain records—the system provides a promising direction for empowering creatives in Rwanda's growing digital economy. Collaboration among stakeholders, including government agencies, tech developers, and creator communities, will be essential in scaling this initiative and fostering a robust digital rights framework across the region.

8. Discussion and Policy Implications

The proposed blockchain-based copyright protection system for Rwanda represents a transformative shift in how digital rights are managed and enforced. The current legal and administrative structures are not fully equipped to respond to the exponential growth of digital content creation, especially as Rwanda continues its digitization journey in sectors such as education, entertainment, and software development. By incorporating blockchain, Rwanda can leapfrog legacy systems and adopt best-in-class solutions tailored to its context.

Policy-wise, this research encourages regulatory authorities, particularly the Rwanda Development Board (RDB) and the Rwanda Utilities Regulatory Authority (RURA), to recognize blockchain records as admissible evidence in IP disputes. Such integration would necessitate amendments to the national IP law, a shift in judicial training, and updated enforcement mechanisms. Awareness campaigns and technical support systems should be developed to onboard artists and creators who may not have prior exposure to decentralized platforms.

In terms of education, integrating blockchain and intellectual property training into secondary and tertiary curricula would empower the next generation of content creators and developers. Universities and polytechnics can play a pivotal role by developing localized blockchain development programs and partnerships with international platforms.

Future Research Directions

This study opens several avenues for future exploration. For instance, empirical evaluation of the system's effectiveness after pilot deployment would help determine real-world applicability. Researchers can investigate user adoption trends, legal validation rates, and cost-effectiveness compared to traditional systems.

Further investigation is also warranted on cross-border IP protection using blockchain, especially within the East African Community (EAC). Smart contracts could potentially standardize royalty mechanisms and licensing protocols across borders, enhancing regional creative trade and collaboration.

Moreover, combining blockchain with artificial intelligence (AI) may lead to autonomous copyright monitoring tools capable of detecting unauthorized content usage across digital platforms in real time. The role of NFTs (Non-Fungible Tokens) in validating and monetizing creative assets should also be examined as they gain traction globally.

Finally, interdisciplinary collaborations between technologists, lawyers, and policymakers will be critical in designing inclusive, sustainable digital rights systems that leave no creator behind.

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