[The Reality of Digital Rights Management Technologies: A Systematic Mapping Study]

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Introduction:

With the proliferation of internet applications and services, human life has become different from what it was before, as the speed and ease of information exchange have increased, alongside the potential number of parties that can exchange information. This also means that the concept of security is no longer limited to the computer that retains the original information but has extended to the security of digital information. Moreover, information security no longer applies only to access to it, but also to what the user can do with that information. Encryption is no longer sufficient, as the user can easily or unintentionally transfer unencrypted information to users who are not authorized to access and view it. Therefore, there is an increasing need for information not only to have mechanisms to control access, but also to determine mechanisms to control how users use the information (Calzada, 2021). Rights and digital management are interconnected in several ways. Digital management refers to the process of managing digital assets, such as data, information, software, and devices. As such, it involves issues related to access to these assets and control over them and their ownership and protection (Mahlmann, 2023). On the other hand, rights refer to the legal and moral rights enjoyed by individuals, or groups for certain actions, resources, or results. In the digital context, rights may refer to a wide range of issues, including intellectual property rights, privacy rights, freedom of expression, and access to information (Gaber et al, 2020; Umeh, 2020). Digital management must take these rights into account when managing digital assets. For example, a company that manages customer data must respect the privacy rights of these customers and ensure the protection of data from unauthorized access or use. In digital asset management, companies must prioritize adherence to intellectual property rights. This involves securing proper licenses or permissions for copyrighted materials used in digital products or services (Calzada et al, 2023). Compliance ensures legal standing, contributing to ethical use and preservation of intellectual property in the digital domain. In addition, the issue of access to digital resources is closely linked to rights. Digital management must ensure access to digital resources for all individuals, regardless of their background or ability (Kishor, 2021). This includes ensuring that digital content is designed in a way that individuals with disabilities can access it. Also, digital management and rights are closely linked, and digital managers must consider various rights issues when managing digital assets (Umeh, 2020). By doing so, they can ensure that their digital products and services are legally compliant, ethically responsible, and accessible to all individuals.

With the increasing initiatives of digital transformation, it has become important to have means and systems that work to protect digital content, preserve the intellectual rights of authors and researchers, and re-engineer processes related to this information to ensure its proper use. Therefore, Digital Rights

Management (DRM) works to solve this problem by employing modern technologies that manage this content legally without reducing the effectiveness and efficiency of the processes relied upon.

The goal of these technologies is to provide a mechanism for the complete lifecycle of content management, focusing on aspects that deal with the management of informational rights and control of use. Many digital service providers sell their digital content over the internet without sufficient protection and serious management of digital rights. Illegitimate copying, modification, and distribution of digital content hinder expansion, development, and innovation. To safeguard intellectual property, there's a pressing need for technologies ensuring effective digital rights management, preventing unauthorized access, and regulating content usage (Nieminen, 2024). By looking at the specifications of digital rights management, DRM systems should provide successful tools and means to ensure permanent protection of content against unauthorized access to content and allow access only to authorized users. Despite extensive exploration by both researchers and practitioners, the current state and extent of pertinent technological developments in this field still lack clarity. Therefore, the method of a systematic mapping study is one of the strong ways to get a general and comprehensive look at the developments taking place in a specific research topic, to provide an unbiased evaluation of current studies, clarify knowledge gaps, and gather evidence for future research directions (Sharma & Aggarwal, 2024).

Keyword: Digital right, Management, Digital right ,Management ,technologies ,Intellectual Property Protection, Copyright ,Protection.

[واقع تقنيات إدارة الحقوق الرقمية: دراسة منهجية لرسم الخرائط]

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الملخص:

تُستخدم تقنيات إدارة الحقوق الرقمية (DRM) لحماية المحتوى الرقمي من الوصول والنسخ والتوزيع غير المصرح به. تتضمن تقنيات إدارة الحقوق الرقمية عادةً تشفير المحتوى والتحكم في الوصول إليه باستخدام المفاتيح والتراخيص الرقمية.

يهدف هذا البحث إلى جمع دراسات الإنتاج الفكري حول إدارة الحقوق الرقمية وتقنياتها، وإجراء تصنيف وتحليل موضوعي لهذه الدراسات، للحصول على فهم شامل لأبرز التقنيات المستخدمة في هذا المجال من حيث الاتجاهات الحالية والمستقبلية، و للتعرف على التحديات التي تواجهها هذه التقنيات في إدارة المحتوى الرقمي. تم إجراء دراسة رسم خرائط منهجية لتحديد وتحليل الأبحاث المتعلقة بتقنيات إدارة الحقوق الرقمية، والتي تغطي المنشورات من عام 2021 إلى عام 2023. وتم تحديد 205 دراسات من قاعدة بيانات Google Scholar، وتم استيفاء معايير التضمين والاستبعاد، وتم إدراج 92 دراسة. وأسفر تحليل هذه الدراسات عن خريطة توضح مجموعة من أبرز التقنيات المستخدمة في هذا المجال ومعرفة اتجاهات وتحديات هذه التقنيات. توصي هذه الدراسة بضرورة إجراء المزيد من الدراسات المستقبلية في مجال إدارة الحقوق الرقمية لمعالجة الفجوات المعرفية لتطوير تقنيات إدارة الحقوق الرقمية وجعلها أكثر فعالية وأمانًا وسهولة في الاستخدام واحترامًا لخصوصية المستخدم والامتثال للمتطلبات القانونية والتنظيمية.

1.1. Study Objectives

The purpose of this study is to classify and map all the research and topics available in the published intellectual production that identify related trends in the literature directly linked to the technologies responsible for managing digital rights and documents in various sectors. A Systematic Mapping Study (SMS) will provide an overview of research areas, research methods, research topics, and modern technologies in managing these digital documents used, research topics, and their results. The detailed objectives of the study can be identified as follows:

- Understand the current research topics related to the technologies and systems associated with digital content management.
- Come out with organized knowledge about the challenges and obstacles facing DRM technologies.
- Identify the knowledge gaps in the field of digital content management that need to be addressed in future studies.
- Identify the most prominent modern technologies that support the management of digital content in all its forms and types during recent years.

2. Previous Studies

Several recent studies have shed light on the intricate landscape of digital intellectual property rights and the evolving mechanisms to safeguard them. Topornin et al (2023) conducted a descriptive analytical study aimed at elucidating the legislative and procedural frameworks governing author's rights and the preservation of digital intellectual property accessible through the Internet. Their findings underscored the Algerian legislator's efforts to adapt to modern technological advancements, particularly in the digital realm, to safeguard authors' rights online. Among the study's recommendations was a call for further exploration into optimal technologies and strategies for protecting digital content while upholding principles of information accessibility and fair use. Similarly, Calzada et al (2023) delved into the realm of Digital Rights Management (DRM) systems, which serve to thwart illicit reproduction and distribution of digital content, thus safeguarding the rights of content owners. However, they highlighted the potential privacy concerns posed by conventional DRM systems. Their study proposed a novel approach to managing digital rights, emphasizing privacy preservation for consumers while ensuring authorized access to digital content, without reliance on third-party intermediaries. They advocated for research into Blockchain technology as a foundational tool for enhancing privacy in digital content management. Building on these insights, Gaffar & Albarashdi (2024) investigated the intricacies of copyright laws and enforcement mechanisms, particularly in jurisdictions like Nigeria and India. Their study examined the delicate balance between authors' rights and public interests, emphasizing the need for comprehensive enforcement of copyright laws. They recommended amendments to existing legislation to align with international standards set by organizations like the World Intellectual Property Organization and the World Trade Organization. Furthermore, they proposed the establishment of regional and international copyright courts to address cross-border infringements effectively. In a related vein, Kim et al (2022) tackled the issue of digital piracy and monopolistic practices within digital content markets. Their study proposed a transformative approach to digital content service, leveraging Blockchain technology to create a decentralized ecosystem termed Smart Digital Content (SPDC). This model aimed to empower content creators and users by offering enhanced security, accessibility, and flexibility in content distribution. Their recommendations included further research into reducing overhead costs associated with the proposed method and experimental evaluations to assess its efficacy in protecting intellectual rights on digital

content. Collectively, these studies contribute to the ongoing discourse on intellectual property protection in the digital age, highlighting the importance of technological innovation and legislative reform to safeguard creators' rights while fostering equitable access to digital content.

3. Overview of the most prominent modern technologies in Digital Rights Management

Digital Rights Management (DRM) refers to the technologies and methods used to manage and protect digital content from unauthorized use, distribution, and piracy. The most common DRM technologies today include encryption, watermarking, and access control. Encryption is defined as a process of converting digital content into a code that can only be read by authorized individuals or devices (Chen et al, 2024). It involves using a set of algorithms to scramble digital content so that it can only be accessed by authorized users using the appropriate decryption key (Chen et al, 2024). Encryption is often used to protect sensitive information such as financial data, personal information, and intellectual property. In Digital Rights Management, encryption is used to prevent unauthorized access and copying of digital content (Nieminen, 2024). Although it is a very effective method for protecting content, it can also be computationally intensive and may require significant processing power and storage capacity (Truong et al, 2023).

On the other hand, watermarking is another important technology. It involves embedding a unique identifier in digital content, which can be used to track the content and identify the source of any unauthorized copies (Calzada et al, 2023; Sharma & Aggarwal, 2024). There are two main types of watermarks: visible or invisible, and they can be added to different types of digital content such as images, video clips, and audio files. Watermarking is often used to deter piracy and track the distribution of digital content. Digital watermarks resemble traditional watermarks, but they are embedded in digital content in a way that is invisible to the human eye (Gaber et al, 2020; Nieminen, 2024). This technology can be used to embed information about the copyright owner, creation date, and other metadata in digital content (Prabowo et al, 2021). This information can be used to track the distribution of digital content and detect unauthorized copies.

Access control is another technology used in DRM. It uses things like digital certificates and secure keys to ensure that only authorized users can access and use protected content (Umeh, 2020). Digital certificates are electronic documents that verify the identity of the user or device trying to access the content. On the other hand, secure keys are encryption keys used to decrypt protected content (Umeh, 2020). Access control technologies are often used alongside encryption to provide an additional layer of protection. In addition to these basic DRM technologies, many DRM systems also use a variety of other technologies to make it difficult for hackers and intruders to bypass the protection. For example, obfuscation technologies can be used to hide encryption keys or other sensitive information used by the DRM system. Obfuscation is a technique used to make digital content difficult to understand or modify (Schloegel et al, 2022). It can include code obfuscation, which involves modifying the source code of a program to make it more difficult to understand, and data obfuscation, which involves modifying the data structure to make it more difficult to interpret. Obfuscation is often used in DRM to prevent reverse engineering and modification of programs. Anti-tampering measures can be used to detect and prevent attempts to modify protected content or the DRM system itself.

There are many new and emerging technologies being developed to improve Digital Rights Management (DRM) and better protect digital content from piracy and unauthorized use. Blockchain is one of the most promising new technologies, a distributed ledger technology that allows for secure and transparent

record-keeping. Using Blockchain, DRM systems can create a decentralized network that provides a greater degree of transparency and accountability, making it difficult for intruders and pirates to bypass the protection (Gaber et al, 2020; Lee et al, 2021). In addition, there is another new technology being developed for digital rights management, which is Artificial Intelligence (AI). AI can be used to analyze large amounts of data and detect patterns and anomalies that may indicate unauthorized use or piracy (Kumar et al, 2023). Using AI-powered DRM systems, content creators and publishers can better monitor their content and quickly identify any instances of piracy or unauthorized use and respond to them (Prabowo et al, 2021). In addition to Blockchain and AI, there are also many other emerging technologies such as cloud computing, augmented reality, and the Internet of Things, all of which have the potential to transform the landscape of digital rights management in the future. These technologies can be used to create more secure and efficient DRM systems, as well as create new revenue sources for content creators and publishers (Truong et al, 2023). It will be interesting to see how these emerging technologies are adopted and integrated into current DRM systems in the coming years. In general, DRM is a complex and multifaceted technology that requires careful study and planning to implement effectively. While DRM can be very effective in protecting digital content, it can also be controversial due to concerns about its impact on user privacy and the potential for misuse by content owners (Gaber et al, 2020).

4. Methodology

To achieve the study's objectives, the content analysis method was adopted using the Systematic Mapping Study approach. This type is defined as a process of identifying, classifying, and analyzing existing literature related to a specific research topic. The aim of the systematic mapping study is to get a comprehensive overview of the research topic, provide an unbiased evaluation of the current literature, identify research gaps, and gather evidence for future research directions. Kitchenham (2004) suggests that the search for primary studies generally starts using an electronic database. The studies presented here include journals and conference papers published and indexed from 2021 to 2023 about Digital Rights Management technologies. Figure (1) illustrates the procedure of the mapping study as follows:
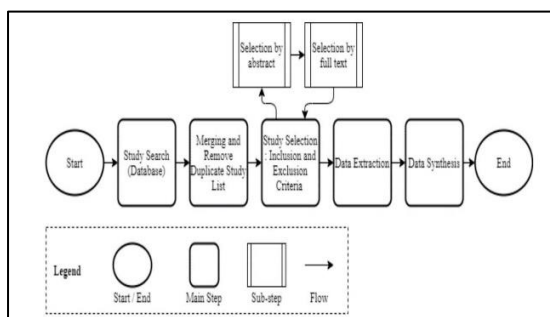

Figure 1: Illustrates the steps of conducting a systematic mapping study (Kitchenham, 2004)

4.1. Defining the research questions

In this step, the research questions that our study aims to answer were identified, which are as follows:

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1. What are the current research topics in the field of Digital Rights Management technologies?
2. What are the challenges facing Digital Rights Management technologies?
3. What are the knowledge gaps that need to be addressed in future studies?
4. What are the most prominent technologies in Digital Rights Management in recent years?

Conducting the search A Systematic Mapping Study (SMS) is a broad overview of the main studies in a specific subject area and aims to identify the available evidence on this topic (Lin et al, 2022; Watson et al, 2022). SMS provides a category-based structure for classifying published research reports and results. SMS is also referred to as secondary research because it maps primary studies on specific topics (Adila, 2024). This indicates that SMS can be said to be a method of getting an overview of the research field (Kitchenham, 2004). The purpose of the SMS is to identify the quantities, topics, and results of the research and to know the directions of publishing. The scope of the study presented here covers Digital Rights Management technologies. The procedure for the mapping study follows these guidelines (Lin et al, 2022; Watson et al, 2022), and mapping practices implemented by both (Lomer & Mittelmeier, 2023).

A comprehensive search was conducted in the bibliographic database Google Scholar. This database will be relied upon because it is the most widespread and specialized in the field of scientific publishing in foreign content. It also distinguished itself as the most cited by specialists and researchers in their studies. The researcher's focus was on including high-quality papers published in conferences, journals, workshops, seminars, and books only. The search was conducted during the last three years between 2021 and 2023 in order to examine the trends of new studies and to what extent the research has reached in this field.

Also, the search was conducted using the English language. A set of different keywords from 3 categories will also be used. The first category included keywords related to Digital Rights Management, including Intellectual Property Protection, Copyright Protection, Digital Right Management, and Technologies. As for the second category, it is related to modern technologies, which was represented by the keyword. As for the third category, it will focus on studying the correlation and relationship between these technologies and Digital Rights Management, where it includes the following words: Relation with.

4.2. Examining Relevant Papers

To examine the search results for papers relevant to the study questions, we followed the search criteria specified in Table (1). Papers that were not relevant based on their titles were excluded. If the title was unclear, the paper's abstract was reviewed. Furthermore, papers that used languages other than Arabic and English, those that did not have a full text available, and duplicate copies were excluded.

4.3. Data Extraction and Mapping

This process was carried out to collect the information needed to address the research questions of this study. Therefore, the researcher designed review criteria that contain six elements for reviewing the papers, as shown in Table (1). The review criteria were tested on a sample of five papers and then applied to the rest of the papers for data extraction.

Standards	Description
The address	Paper title
Author	Authors' names
Date of publication	Specific year of publication
The language	The language used by the study
Paper type	Conference, Journal, Book chapter or working paper
Availability	Available in the full version
Summary	Overview of the paper

Table 1: Show the criteria for extracting studies.

4.4.Study Testing

Inclusion and exclusion criteria are used to select the papers that will be analyzed in the mapping study. To accomplish this step, we followed the sorting approach described by (Yli-Huumo et al, 2016), and the specified inclusion/exclusion criteria.

4.4.1. Inclusion Criteria

To consider including studies, the research being evaluated must come from an academic source, such as a journal, conference, or books, and it must clearly show that its contribution focuses on applying DRM technologies. Studies can be accessed electronically. The paper title includes "DRM technologies".

4.4.2. Exclusion Criteria

For those studies that passed the inclusion criteria, the "focus on technologies" criterion was applied to reduce the studies to those that were directly considered compatible with the study's focus. The exclusion criteria were applied to the titles, keywords, abstracts, and full text.

Exclusion criteria	Inclusion criteria
Studies that are not in English	Studies available in full text
Studies outside the field of study	Studies in English
Non-academic studies	Studies conducted in the specific field of study (by title-abstract)
Unavailable studies cannot be accessed in full text	Studies during the year 2021 to 2023

Table 2: Shows the inclusion and exclusion criteria.

The inclusion and exclusion criteria in Table (2) were applied through manual review of the paper contents starting from reading the title and abstract and selecting all publications that were not related to Digital Rights Management technologies. Preliminary 205 studies were identified, then 181 studies were produced based on the inclusion and exclusion criteria represented in Table (2). Also, out of 181 studies, 92 studies were selected based on the full text that presents the publications in the field of study. The study selection process is shown based on the PRISMA model, which illustrates the flow of data and procedures in Figure (2).
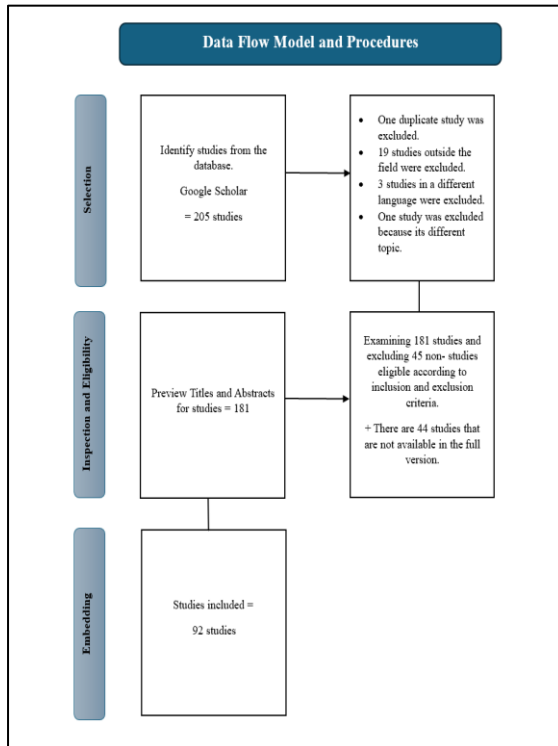
4.5. Data Flow and Procedures Model

Figure 2: Illustrates the data flow and procedures (PRISMA)

5. Discusses

What are the current research topics in the field of Digital Rights Management technologies?

One of the current trends in Digital Rights Management technologies is the use of several technologies over the past three years. From the results, we find that there are technologies that have been researched and tested for their interaction and application in several fields. An example of these technologies is the Blockchain technology for Digital Rights Management. DRM systems based on Blockchain provide several advantages, including decentralized control, transparency, and stability. In addition, they enable content owners to track and manage the distribution of their digital content in a safe and efficient manner (Garba et al, 2021; Kobilov et al, 2022).

In addition, there are studies that pointed to a group of general technologies represented in big data, data mining, cloud computing, and many more, which play an important role in Digital Rights Management. The use of machine learning and artificial intelligence (AI) can help detect and prevent unauthorized sharing of digital content. Machine learning algorithms can analyze patterns in user behavior to identify potential copyright violations, while AI-supported content recognition systems can automatically detect copyright-protected materials in video clips and other digital content (Kumar et al, 2023). In addition, peer-to-peer DRM platforms have become increasingly popular, as they provide scalability, flexibility, and cost-effectiveness (Kim et al, 2022). Cloud-based DRM solutions can protect digital content across multiple platforms and devices, also can be easily integrated with other systems and applications.

What are the challenges facing Digital Rights Management technologies?

The technologies used for Digital Rights Management (DRM) face several challenges. Through the analysis of the studies that discussed this field, they were summarized in the following points (Ebrahimpour & Babaie, 2024; Wu et al, 2022):

Compatibility: It may be difficult to implement Digital Rights Management technologies across multiple devices and platforms, which may limit their effectiveness in controlling access to and use of digital content.

Security vulnerabilities: Digital Rights Management technologies are vulnerable to hacking and other security threats, which can expose the privacy and security of protected content to risk.

Complexity: Digital Rights Management technologies can be complex and difficult to use, especially for small content creators and distributors who may lack the resources needed to effectively implement these technologies.

Legal challenges: Disaster risk management technologies have faced legal challenges, particularly in relation to their impact on fair use and other consumer rights. Critics argue that Digital Rights Management can limit the ability to legally use digital content, such as making copies for backup purposes or using excerpts for educational or critical purposes.

Consumer Resistance: Some consumers resist Digital Rights Management technologies, considering them overly restrictive and inconvenient. This can lead to a violent reaction against content protected by a Digital Rights Management system and a preference for freely available or easily shareable content.

Lack of Standardization: There is a lack of standardization in Digital Rights Management technologies, which can lead to confusion and inconsistency in how to protect and access digital content across different platforms and devices.

Cost: Digital Rights Management technologies can be costly to implement, especially for small content creators and distributors who may lack the necessary resources to invest in these technologies.

Privacy Concerns: Some Digital Rights Management technologies collect and transmit user data, which may raise privacy concerns. For example, some Digital Rights Management systems may track user behavior or preferences, which can be used for targeted advertising or other purposes.

The technologies used in Digital Rights Management face many of the same challenges that Digital Rights Management itself faces, including compatibility, security, legal issues, and consumer-related issues. As the digital content market continues to evolve, it will be important for Digital Rights Management technologies to adapt to these challenges in order to effectively protect digital content and ensure fair compensation for creators for their work.

What are the knowledge gaps that need to be addressed in future studies?

There are several knowledge gaps in Digital Rights Management (DRM) technologies that need to be addressed in future studies. The results of the analysis of 12 studies where these trends were discussed showed that there are modern technologies that research seeks to study deeply and apply in all types of DR to address some challenges in this field, examples of which are Blockchain technology, AI

technologies, machine learning, big data technology, and data mining methods. DRM technologies have been developed to protect the intellectual property rights of digital content creators and publishers (Ebrahimpour & Babaie, 2024). However, there are still many knowledge gaps that need to be addressed in future studies of DRM technologies. There is a need to explore the effectiveness of these technologies in preventing piracy and unauthorized access to digital content. This includes examining vulnerabilities in current Digital Rights Management systems and identifying ways to improve their security (Gebremichael et al, 2020). On the other hand, there is a need to investigate the impact of DRM technologies on user behavior and attitudes towards digital content. This includes understanding the factors that affect users' willingness to pay for content and the extent to which DRM restrictions affect their consumption patterns. In addition, the ethical and legal implications of DRM technologies should be revealed, especially in relation to privacy, freedom of expression, and fair use. This includes examining the compatibility of DRM systems with current copyright laws and evaluating their potential impact on user rights and freedoms (Gebremichael et al, 2020; Karandas, 2023). Addressing these knowledge gaps will be crucial in developing more effective and user-friendly DRM technologies that balance the interests of content creators and users.

What are the most prominent technologies in Digital Rights Management in recent years?

Over the past three years, there have been several developments in DRM technologies. The studies that have been analyzed have shown that one of the most prominent developments is the increasing use of Blockchain technology to provide secure and decentralized DRM solutions. DRM systems based on Blockchain offer several advantages, including increased transparency and accountability, as well as improved tamper and piracy resistance (Garba et al, 2021). Another significant trend is the integration of Artificial Intelligence (AI) and Machine Learning (ML) into DRM systems, which allows for more complex content protection and user identification technologies (Harahap et al, 2021; Zhang et al, 2022). For example, AI and ML algorithms can be used to detect and prevent unauthorized content sharing and identify suspicious user behavior (Kumar et al, 2023). In addition, there has been an increasing focus on developing DRM solutions that are easier to use and adaptable to different types of content and distribution models. This includes the use of more flexible licensing models, such as subscription-based and pay-per-view models, in DRM systems and services based on peer-to-peer networks. In addition, the latest developments in Digital Rights Management technologies aim to provide more secure, effective, and user-friendly solutions to protect digital content and intellectual property rights. A diagram was made to highlight these technologies, as shown in Figure (3).
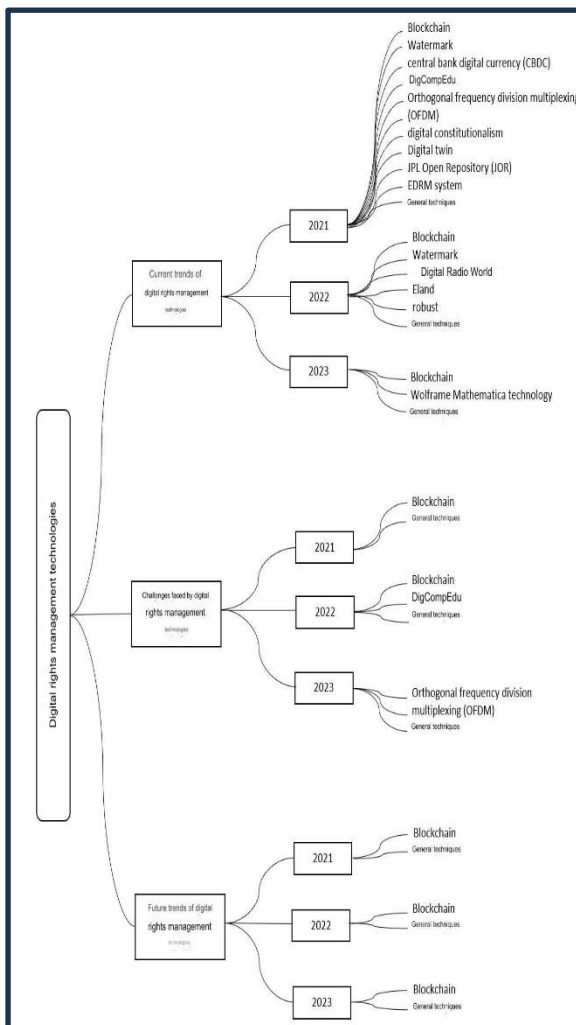
Figure 3: Shows the classification diagram for Digital Rights Management

The previous classification diagram, represented in Figure (3), highlights the most specialized technologies in managing digital documents, where it was based on the following three main axes: current trends in Digital Rights Management technologies, the challenges facing these technologies, and the future trends in the same field during the last three years from 2021 to 2023.

6. Conclusion

This study provided a comprehensive and systematic survey of the literature related to the technologies used in Digital Rights Management. The results of the research questions gave a comprehensive understanding of the reality of these technologies from several aspects, including current trends, the challenges facing these technologies, and future trends over the last three years. In addition, it was possible to reach a classification diagram for the most prominent technologies used in the field of DRM, which in turn work to protect digital content from unauthorized access, copying, and distribution.

From the above, several recommendations can be made as follows:

1. Work on improving interoperability: As previously mentioned, DRM technologies can sometimes create compatibility problems, especially when using different systems to access the same content. Future work can focus on developing more interoperable DRM systems that reduce these problems and allow users to access content across multiple platforms and devices.
2. Improve user control by developing more flexible licensing models that allow users to share content with friends or family members or provide more options for backing up content or transferring it between devices.
3. Work on exploring ethical considerations related to user privacy and freedom of expression and develop DRM systems that achieve a suitable balance between protecting the rights of content creators and respecting user privacy and freedom of expression.
4. With the continued emergence of new technologies such as Blockchain and decentralized storage systems, there may be opportunities to develop new DRM systems that benefit from these technologies to provide a greater degree of security, flexibility, and user control over protected content.
5. Future studies in DRM should aim to address knowledge gaps in order to develop more effective, secure, and user-friendly DRM technologies that respect user privacy and comply with legal and regulatory requirements.

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