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BLOCKCHAIN TECHNOLOGY AND SMART CONTRACTS: LEGAL IMPLICATIONS AND FUTURE REGULATIONS

TEKNOLOGI BLOCKCHAIN DAN KONTRAK PINTAR: IMPLIKASI HUKUM DAN REGULASI MASA DEPAN

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ABSTRACT
In recent decades, digital technologies, especially blockchain and smart contracts, have significantly changed the legal and contractual paradigm. However, the main challenge faced is the legal uncertainty regarding the recognition and enforcement of smart contracts in various jurisdictions. This research aims to explore how smart contracts can be recognized and enforced within existing legal frameworks in various legal systems, including common law and civil law. Using a Systematic Literature Review (SLR) approach, this research identifies, analyzes and synthesizes relevant literature from leading academic databases. Strict inclusion and exclusion criteria were applied to ensure the validity and relevance of the data. The findings show that legal recognition of smart contracts varies significantly between countries, with some countries having adopted supportive regulations, while others are still stuck in traditional legal interpretations. This research also identifies the urgent need for harmonization of international law to address existing uncertainties. These findings have important implications for policy makers and legal practitioners, highlighting the need for legal reform that is responsive to technological innovation. This research contributes to the development of more adaptive legal theory and practice in facing digital challenges.
Keywords: Smart Contracts, Blockchain, Legal Recognition, Legal Harmonization, Legal System.

ABSTRAK
Dalam beberapa dekade terakhir, teknologi digital, khususnya blockchain dan smart contracts, telah mengubah paradigma hukum dan kontraktual secara signifikan. Namun, tantangan utama yang dihadapi adalah ketidakpastian hukum terkait pengakuan dan penegakan smart contracts di berbagai yurisdiksi. Penelitian ini bertujuan untuk mengeksplorasi bagaimana smart contracts dapat diakui dan ditegakkan dalam kerangka hukum yang ada di berbagai sistem hukum, termasuk common law dan civil law. Menggunakan pendekatan Systematic Literature Review (SLR), penelitian ini mengidentifikasi, menganalisis, dan mensintesis literatur yang relevan dari database akademik terkemuka. Kriteria inklusi dan eksklusi yang ketat diterapkan untuk memastikan validitas dan relevansi data. Temuan menunjukkan bahwa pengakuan hukum terhadap smart contracts bervariasi secara signifikan antar negara, dengan beberapa negara telah mengadopsi regulasi yang mendukung, sementara yang lain masih terjebak dalam interpretasi hukum tradisional. Penelitian ini juga mengidentifikasi kebutuhan mendesak untuk harmonisasi hukum internasional guna mengatasi ketidakpastian yang ada. Temuan ini memiliki implikasi penting bagi pembuat kebijakan dan praktisi hukum, menyoroti perlunya reformasi hukum yang responsif terhadap inovasi teknologi. Penelitian ini berkontribusi pada pengembangan teori dan praktik hukum yang lebih adaptif dalam menghadapi tantangan digital.
Kata Kunci: Smart Contracts, Blockchain, Pengakuan Hukum, Harmonisasi Hukum, Sistem Hukum.

1. INTRODUCTION

In recent decades, digital technology has spurred considerable transformation across various sectors, notably within the legal and contractual domains. At the forefront of these changes is blockchain technology—a decentralized digital ledger system endowed with features such as transparency, security, and data immutability, which are vital for reinforcing trust in digital transactions (Shelake, 2025). Building upon this foundation, smart contracts have

emerged as a revolutionary concept. First introduced by Nick Szabo in 1994, smart contracts are digital self-executing agreements written in code, which automatically enforce contractual terms once predetermined conditions are fulfilled (Chauhan, 2020).

The advantages of smart contracts are multifaceted. By automating contractual agreements, these digital protocols significantly minimize reliance on intermediaries, thereby decreasing transaction costs and the risks associated with moral hazards (Eenmaa & Schmidt-Kessen, 2019). Moreover, they operate autonomously on blockchain networks, ensuring minimal need for human intervention, which fosters efficiency and transparency (Shelake, 2025). However, the integration of smart contracts into the existing legal framework brings forth complex challenges. Primary among these challenges is the question of legal validity: traditional contract law stipulates fundamental elements such as agreement, capacity, and consideration, which may not seamlessly align with the algorithmic nature of smart contracts (Chauhan, 2020).

A central issue is the regulatory environment's inadequate alignment with the rapid technological developments surrounding smart contracts. Much of the existing legal framework is static and text-based, while smart contracts are dynamic and coded. This dichotomy results in a regulatory lag, which leaves many jurisdictions grappling with legal uncertainties (Levy, 2017). Efforts to adapt the law to accommodate this novel technology have been inconsistent. For example, while some countries like the U.S. and U.K. have begun to incorporate digital contracts into formal legal frameworks, many others remain constrained by traditional interpretations of contract law, highlighting the absence of a unified global legal standard for smart contracts (Shelake, 2025).

Moreover, the implications of smart contracts extend beyond mere legal recognition; they pose significant challenges for dispute resolution mechanisms. Unlike traditional contracts that facilitate human arbitration, the automated nature of smart contracts necessitates new frameworks for addressing breaches or failures in the underlying code (Chauhan, 2020). As they stand, smart contracts offer great potential as tools of digital transformation. However, unless adequate legal structures evolve in tandem with technological advancements, their effective integration will remain hindered by ambiguity and uncertainty (Dmytryk et al., 2022).

Although the literature on smart contracts continues to grow, there remains a gap in cross-jurisdictional comparative studies that address how smart contracts can be legally recognized and enforced across different legal systems. Most studies still focus on single jurisdiction analysis or only discuss the technological aspects without in-depth exploration of the legal dimensions. In addition, the lack of a systematic approach in compiling a comparative legal synthesis means that global understanding of the enforceability of smart contracts is still partial and fragmented.

Based on the background and research gaps that have been identified, this study seeks to answer the following main questions: **How can smart contracts be legally recognized and enforced within existing legal frameworks across different jurisdictions?** This question reflects the urgency to understand in depth how each legal system works whether based on common law, civil law, or mixed systems—responding to and accommodating the development of smart contracts. In this context, the recognition and legal enforcement of smart contracts depends not only on technological sophistication, but also on the ability of existing legal frameworks to adapt to forms of contracts that are digital, automated, and often cross traditional jurisdictional boundaries. Therefore, it is important to explore the extent to which conventional contract law principles, such as the principles of freedom of contract, consensualism, and good faith, can be transformed without sacrificing fundamental values such as justice, legal certainty, and protection of the parties. By answering this question, this study aims to contribute to formulating a legal approach that is not only responsive to technological innovation, but also consistent with the basic principles in the legal systems that apply in various countries.

This research makes significant contributions to the realm of law and technology in several crucial ways. First, this research provides an in-depth comparative legal synthesis of the approaches taken by various countries in regulating smart contracts. This includes comparisons of regulations applied in various jurisdictions, evolving jurisprudential interpretations regarding the recognition and enforcement of smart contracts, as well as implementation practices adopted by various legal systems. By analyzing the differences and similarities in the legal application of smart contracts, this study provides greater insight into how different countries are responding to this new phenomenon.

Second, this research develops a conceptual framework that can be a reference for policy makers in formulating regulations that are responsive and adaptive to developments in smart contract technology. This framework considers universal principles in contract law, such as freedom of contract, protection of the weaker party, and legal certainty. Thus, this research not only focuses on positive legal aspects, but also offers a philosophical basis that can guide fair and sustainable regulation.

Through a systematic literature review (SLR) approach, this study seeks to provide a holistic and evidence-based picture of the dynamics of smart contract legalization at the global level. By integrating findings from various relevant literature, This research offers a thorough and comprehensive analysis of the challenges and opportunities that exist in the legalization of smart contracts. Apart from that, this study also offers policy recommendations that can support harmonious integration between technology and law, so that innovation in the field of smart contracts can develop while maintaining the principles of justice and legal certainty throughout the world.

2. METHODS

2.1. Research Design

This research uses a Systematic Literature Review (SLR) approach to identify, analyze and synthesize literature related to the legality and enforceability of smart contracts in various global legal systems. This method was chosen because it provides a systematic and transparent framework for evaluating existing academic evidence, and is very suitable for answering normative and comparative research questions. To ensure traceability and validity of the literature review process, this study adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which have become standard international standards in reporting SLR studies.

2.2. Inclusion and Exclusion Criteria

So that the literature selection process is objective and relevant to the research focus, the following inclusion and exclusion criteria are set:

- **Inclusion Criteria** includes:
    - The article telah through a peer-review process, as an indicator of scientific quality and validity.
    - Studies originating from legal and interdisciplinary disciplines (for example: technology-law, law-economics, or law-computer) which explicitly discuss legal recognition and enforcement of smart contracts.
    - The publication period is between 2010 and 2025, reflecting the latest developments in regulatory and legal thinking regarding smart contracts.
    - Studies that review or analyze relevant national or international legal frameworks.

- **Exclusion Criteria** includes:
    - Articles that are not published in academic journals, such as blogs, industry reports, or unofficial documents.

- Studies that do not discuss legal aspects or focus solely on the technical and systems engineering side of smart contracts, without considering the normative or regulative dimensions.
- Publications that contain only narrative opinions without verifiable scientific methodology.

These criteria are designed to ensure that only literature is relevant, credible, and contributes to the understanding of legal enforcement ability dari smart contracts yang analyzed in this study.

2.3. Data source

Secondary data was collected from a number of reputable academic databases covering legal and technology disciplines, including:

- Scopus
- Web of Science
- Springer

The combination of these three databases allows for comprehensive, cross-jurisdictional literature searches.

2.4. Search Strategy

The literature search strategy in this research was carried out using techniques Boolean search, which enables more focused and structured searches in academic databases. This technique utilizes a combination of main keywords and relevant legal terms, so it can cover various points of view and context regarding the topic of smart contracts. The main search formulas used are: **“smart contract” AND “legal enforcement” AND “jurisdiction” OR “legal framework” AND “recognition”.** These keywords were chosen taking into account the terminology frequently used in academic discourse related to law and technology. Terms such as “smart contracts” and “legal enforcement” represent the core of the research topic, while “jurisdiction,” “legal framework,” and “recognition” describe legal elements that are crucial in the context of legal recognition and enforcement of smart contracts.

This search process is iterative, meaning it is carried out several times to perfect the search results. This process involves adjusting relevant synonymous terms, spelling variations, as well as checking the relevance of the results found to ensure that the literature taken is truly related to the topic being researched. With this approach, it is hoped that we can obtain more comprehensive and representative results from various perspectives, as well as reduce the potential for bias or limitations that may arise due to the use of keywords that are too narrow or inappropriate.

2.5. Literature Selection Process

The literature selection process follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow which consists of four main stages:

1. Identification: Finds and collects all suitable articles from a database determined based on search keywords.
2. Screening: Remove duplicates and review titles and abstracts to filter out irrelevant articles.
3. Eligibility: Assess articles in full based on full text against inclusion and exclusion criteria.
4. Inclusion: Compile a final list of articles that will be analyzed in depth in this study.

A PRISMA diagram will be used to visualize the number of articles screened at each stage, including the reasons for exclusion.

2.6. Data Analysis Techniques

After the final article was determined, the data was analyzed using a thematic coding and framework analysis approach. This approach allows the identification of main themes and conceptual frameworks from the selected literature. The analysis process includes:

1. Initial coding to group the content of articles into certain legal themes such as enforceability principles, jurisdictional recognition, and national legal framework.
2. Thematic mapping to identify the relationship between the legal approach used and the context of each jurisdiction.
3. Categorize findings based on:
    a. Jurisdiction (eg: common law vs civil law),
    b. Legal approach (for example: positivist vs normative approach), and
    c. Legal theories used (for example: classical contract theory, justice theory, cyber law theory)

This technique helps build a systematic and integrative narrative to answer research questions and develop a conceptual framework that can base policy recommendations.

3. RESULTS

3.1. Characteristics of Reviewed Studies

3.1.1. Prisma Diagram

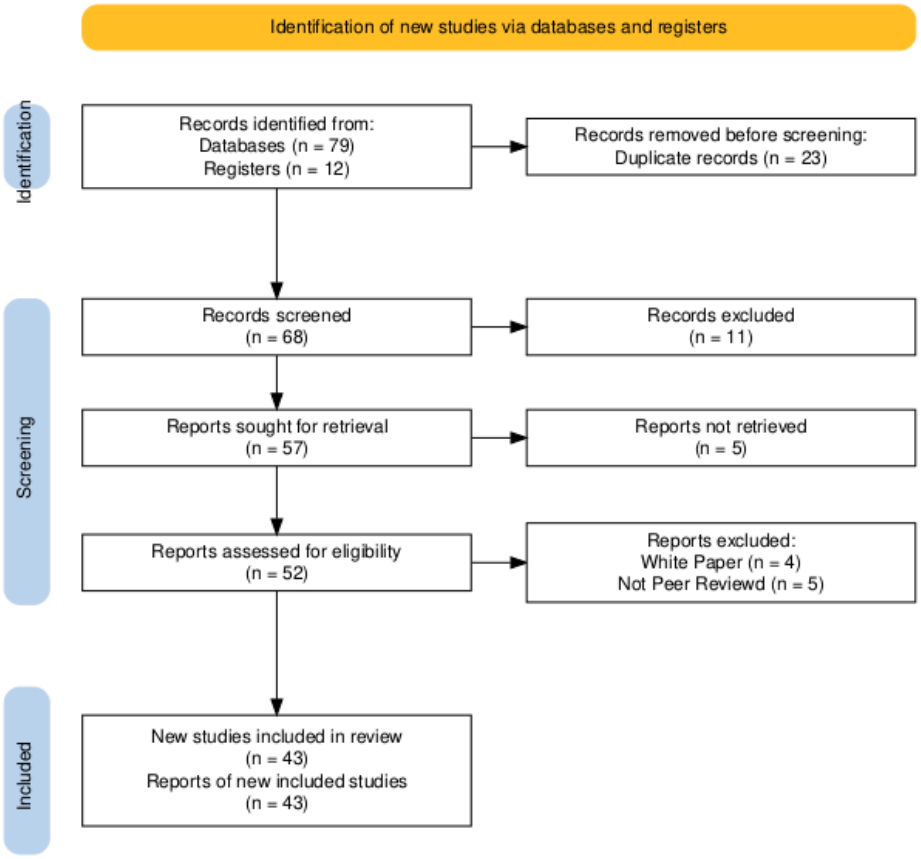

Figure 1. Prisma Diagram
Source: Processed Data, 2025

At the identification stage, a total of 91 records were collected from two main sources, namely 79 records from academic databases and 12 records from registration. Before proceeding to the filtering stage, an elimination process was carried out on 23 records

identified as duplicates. Next, in the screening stage, a total of 68 records were reviewed to assess their relevance to the research topic. Of these, 11 records were eliminated because they did not meet the predetermined inclusion criteria. The process continued with requests to retrieve 57 full reports, but 5 of them were unsuccessful. At the feasibility evaluation stage, 52 reports were successfully accessed and studied further. Among these reports, 4 were white papers and the other 5 did not go through a peer-review process, so they were excluded from the analysis. Ultimately, 43 new studies were deemed eligible and included in this systematic review, with the number of reports reviewed also being 43. This process provides a comprehensive overview of the systematic stages applied in identifying, filtering, and evaluating relevant studies, thereby ensuring the quality and validity of the findings in this systematic literature review.

3.1.2. Number and Distribution of Studies

Figure 2. Article Distributions
Source: Processed Data, 2025

From an analysis of the number and distribution of references registered between 2010 and 2025, it can be seen that there are a total of 43 references covering various legal, technology and reform topics.

2010 is the starting point with two references, showing that attention to legal and technological issues began to emerge in that period. In 2013, only one reference was recorded, indicating that progress in this field is still relatively slow.

However, starting in 2015, the number of references began to increase with three publications, and this trend has continued. 2016 recorded one reference, but in 2017, there was a significant spike with four references, indicating increased interest and research in the fields of law and technology, particularly related to smart contracts and blockchain.

2018 and 2019 recorded two and five references respectively, indicating that these topics are gaining increasing attention among academics and legal practitioners. 2020 also saw three references, showing that despite global challenges, research in this area continues.

2021 and 2022 recorded five and four referrals respectively, indicating that interest in smart contracts and legal reform continues to increase. 2023 also recorded five references, indicating that research and discussions on legal issues related to digital technology and smart contracts are growing.

Finally, 2024 recorded five references, showing that this trend not only continues but is increasingly relevant in today's digital era. The year 2025, even though only one reference has been recorded, shows that research in this field is still active and has the potential to develop further.

Overall, these data reflect significant growth in research and discussion regarding law, technology, and reform, with a particular focus on smart contracts and related legal implications.

3.1.3. Geographic Distribution

One of the main focuses of this SLR is to explore how different legal systems respond to the existence of smart contracts. Therefore, the analyzed studies are categorized according to the following main legal traditions:

Table 1. Geographical Distribution

Country	Law System	Article
United States of America	Common Law	6
English	Common Law	2
You have	Common Law	1
Australia	Common Law	1
German	Civil Law	2
French	Civil Law	1
Japan	Civil Law	1
Indonesia	Civil Law	2
Singapore	Hybrid	2
South Africa	Hybrid	1
Scandinavian countries	Hybrid	1
Others (not identified)		23
Total		**43**

Source: Processed Data, 2025

From the analysis of the geographical distribution of references listed by legal system, it can be seen that there are a total of 43 articles covering various countries and different legal systems.

Countries with Common Law legal systems, such as the United States, United Kingdom, Canada, and Australia, show a significant number of references. The United States dominates with 6 articles, reflecting its important role in research and development related to smart contracts and legal technology. The UK follows with 2 articles, while Canada and Australia each contribute 1 article. This shows that countries with Common Law systems tend to be more flexible in accommodating legal innovation through principles that develop from precedent.

On the other hand, countries with Civil Law systems, such as Germany, France, Japan and Indonesia, also have significant contributions. Germany and Indonesia each recorded 2 articles, while France and Japan each had 1 article. The adaptation of smart contracts in these countries is often faced with challenges caused by strict legal codification and attachment to normative texts, which can limit flexibility in the application of new technologies.

The Hybrid legal system, which includes Singapore, South Africa and the Scandinavian countries, represents an innovative approach to integrating technology into the formal legal system. Singapore recorded 2 articles, while South Africa and the Scandinavian countries each had 1 article. This suggests that countries with mixed legal systems seek to combine elements of both legal systems, leaving room for greater innovation and adaptation.

In addition, there were 23 articles that were not clearly identified in the context of a particular country or legal system. This may reflect more general research or theory that is not tied to a single jurisdiction, but remains relevant to the topics of smart contracts and legal technology.

Overall, these data show that research on smart contracts and legal technology is growing rapidly in countries with different legal systems, each with unique challenges and opportunities in adopting legal innovations.

This geographic distribution allows mapping of diverse legal responses, as well as highlighting the existence of normative disparities between regions in responding to developments in digital contract technology.

3.1.4. Study Methodology

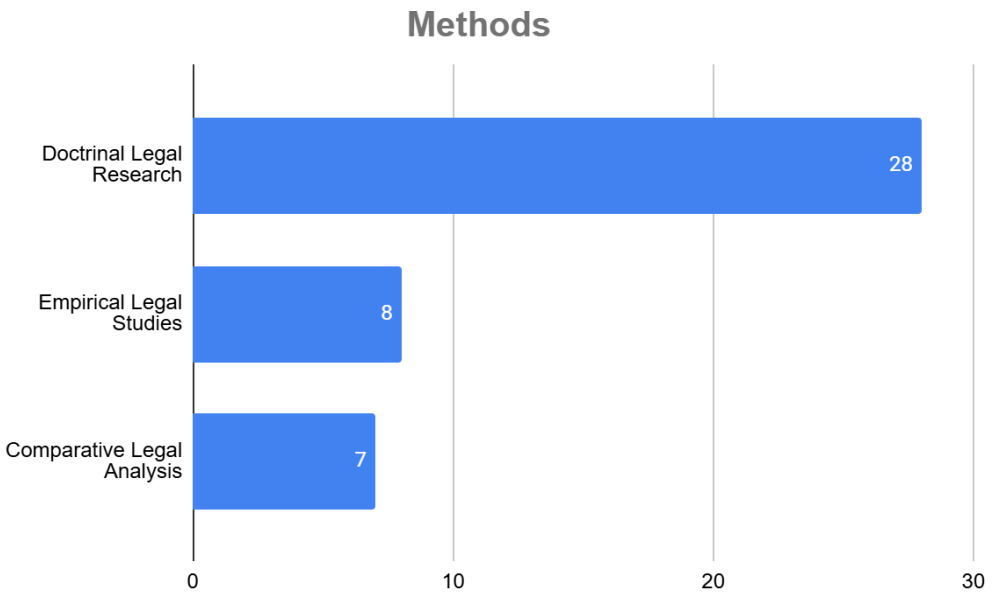

Figure 2. Methods
Source: Processed Data, 2025

Methodological analysis of studies registered from 2010 to 2025 shows a significant variation in approaches in research on smart contracts and legal technology. The majority of studies, 28 references, used the approach Doctrinal Legal Research, which is normative-dogmatic in nature. This approach focuses on reviewing relevant legal regulations and precedents, as well as analyzing the validity of smart contracts within the framework of conventional contract law. This reflects that many researchers seek to understand and interpret how existing laws can be applied in the context of new technologies. Apart from that, there are

8 references that have adopted it Empirical Legal Studies, where some studies use survey methods or secondary data analysis to measure legal stakeholder perceptions, regulatory effectiveness, and implementation challenges in the field. This approach represents an effort to gain practical insights and empirical data that can support policy and regulatory development. Lastly, 7 references did Comparative Legal Analysis, in which several articles conduct cross-country comparative analysis to assess the strengths and weaknesses of existing regulatory approaches, as well as identify universal principles that can be used as a basis for global legal harmonization. Overall, these data reflect that although the normative-dogmatic approach predominates, there is also significant attention to empirical studies and comparative analysis, indicating efforts to understand and overcome the challenges faced in the implementation of smart contracts in various jurisdictions. The presence of these various approaches enriches understanding of the legal dimensions of smart contracts, both in terms of theory and practice.

3.2. Key Findings

Smart contracts, as digital agreements encoded in computer protocols, demonstrate transformative potential in contractual relationships across various sectors. Their legal recognition, enforceability, and theoretical foundations exhibit significant variation globally, resulting in both opportunities and complications.

1. Variations in Legal Recognition of Smart Contracts

The legal status of smart contracts differs markedly between jurisdictions. Some nations have made strides in recognizing these contracts through specific legislation, exemplified by the U.S. Uniform Electronic Transactions Act and the UK Electronic Trade Documents Act, which endorse electronic and digital contracts under certain frameworks Zheng et al., 2020). Conversely, in many regions, legal recognition remains vague, limited primarily to the technical functionalities of the contracts, lacking definitive guidance on enforceability or the full implications of their execution (Yusof et al., 2024; . The challenge lies in a legal landscape that has yet to fully catch up with the technological advancements underlying smart contracts, rendering their enforceability often ambiguous in practice (Đurović & Lech, 2019)

2. Barriers to Enforceability in Traditional Legal Systems

Enforcing smart contracts within traditional legal systems poses significant challenges due to inherent inconsistencies between automated processes and established contract law principles, such as mutual consent, consideration, and formalized documentation (Đurović & Lech, 2019; . For instance, ambiguity in coding can lead to disputes over interpretation, which traditional legal systems may struggle to address adequately. Moreover, the absence of mechanisms for dispute resolution further complicates the enforceability of these contracts, as stakeholders may find themselves in contentious situations without a clear path for remediation (Gürgün & Koç, 2021; Kunkcu et al., 2023). Legal scholars note that legal systems must adapt to integrate innovative contractual forms that are responsive to technology while also protecting users' rights (Peters & Panayi, 2015).

3. Contributions of Legal Theory

The integration of smart contracts into legal frameworks is informed by multiple legal theories that address existing deficits and propose pathways forward. Classical and modern contract theories provide insights into the structure and implications of these new agreements, highlighting the need for foundational understandings of contract law to evolve alongside technological advancements (Đurović & Lech, 2019; Zheng et al., 2020). The Legal Certainty Theory underscores the necessity of formal regulations to mitigate ambiguities, emphasizing

that without clear legal recognition and guidelines, smart contracts may perpetuate uncertainties that pose risks to all parties involved (Yusof et al., 2024; Atiyah et al., 2023). Furthermore, the Technology Regulation Theory advocates for flexible regulatory measures that can accommodate technological innovations while safeguarding against potential abuses, thus aligning legal practices with contemporary operational realities in the digital landscape (Đurović & Lech, 2019; Wright & Serguieva, 2017).

In conclusion, while the advancements in smart contracts herald significant potential for innovation across various sectors, the complex interplay between technology and existing legal structures underscores the necessity for continuous research, legislative adaptation, and interdisciplinary collaboration to foster an environment conducive to their effective implementation and enforcement.

4. DISCUSSIONS

4.1. Synthesis of Findings

Based on thematic analysis of the articles reviewed, several main syntheses were obtained that reflect the dynamics and challenges in the recognition and enforcement of smart contracts in various jurisdictions:

1. Comparison of Legal Frameworks Between Countries

The exploration of differing legal frameworks among countries reveals a spectrum of systems influenced by historical, social, and cultural contexts. Common law systems, predominantly utilized in countries such as the United Kingdom and the United States, exhibit a robust flexibility through jurisprudential interpretation, allowing dynamic adaptation to emerging social and technological contexts (Taekema, 2018). On the other hand, civil law systems, evident in nations like France and Germany, are characterized by legal codification, which can limit adaptability and responsiveness to change (Zumbansen, 2010). The systematic codification in civil law offers stability and clarity; however, it may hinder the rapid evolution of laws that reflect modern societal needs (Přibáň, 2015).

Conversely, hybrid legal systems, such as those in Indonesia, exemplify a transformative approach where various legal traditions coalesce to address contemporary issues. These systems may incorporate elements from both common and civil law, thereby fostering innovative practices aimed at legal reform and policy enhancement (Chairani et al., 2024). The integration of such diverse practices is crucial for responding effectively to globalization and transnational challenges (Zumbansen, 2010). Legal pluralism arises prominently in this context, emphasizing the coexistence of multiple legal systems and the implications this has on law-making and enforcement (Zumbansen, 2010).

The narrative surrounding legal reforms is likewise shaped by collaborative frameworks where cross-sector partnerships can stimulate necessary changes within legal infrastructures (Teitelbaum et al., 2019). For instance, the Justice Collaborator program in Indonesia showcases how collaborative strategies between law enforcement and key stakeholders can lead to the dismantling of organized crime and enhance justice mechanisms (Chairani et al., 2024). Such collaborations are also echoed in the realm of medical-legal partnerships, where integrated approaches are found to bridge gaps between legal, medical, and public health systems, leading to improved outcomes for vulnerable populations (Sandel et al., 2010).

In summary, the adaptability of legal systems—be they common law, civil law, or hybrid—is heavily influenced by both internal and external factors. The necessity for collaboration emerges as a critical component in addressing systemic inequalities and ensuring a legal landscape that is responsive to the needs of diverse populations. Legal reforms must, therefore, leverage adaptable frameworks that capitalize on the strengths of each system while fostering effective partnerships to navigate the complexities of modern governance (Canfield, 2018).

The legal frameworks across various jurisdictions significantly influence their adaptability, enforcement, and effectiveness. Common law systems, known for their reliance on jurisprudential interpretation, provide greater flexibility to address changing societal needs. Such adaptability allows these systems to evolve through case law, encouraging innovative solutions to legal disputes (Kasatkina, 2021). Conversely, civil law countries often adhere to rigid codifications, which may hamper legal responsiveness and necessitate comprehensive reforms to align with modern developments (Reyad, 2023). Countries with hybrid legal systems strive for a balanced approach, combining elements from both common and civil law frameworks, which promotes dynamic reform processes (Akpuokwe et al., 2024; Mugasha, 2017).

The necessity for legal reform is underscored by an increasingly globalized legal landscape where jurisdictional conflicts can arise, particularly in areas such as smart contracts. The absence of universally recognized standards contributes to legal uncertainty and challenges in enforceability across borders (Levy, 2017; Efrat, 2015). Scholars advocate for the harmonization of legal principles to establish minimum guidelines that secure the rights of parties involved in cross-border transactions and mitigate potential disputes stemming from divergent legal interpretations (Burris et al., 2016). This harmonization is essential not only for commercial certainty but also for fostering international trade by reducing transaction costs linked to legal ambiguities (Buryk et al., 2022; Herlindah & Darmawan, 2022).

2. The Need for Reform and International Standards

The burgeoning field of smart contracts necessitates urgent reforms within national legal systems and the establishment of international standards to address the complex legal frameworks that arise from their usage. As this technology develops, the absence of clear global guidelines could lead to jurisdictional conflicts and legal ambiguities that compromise the enforceability of contracts across borders. There is a consensus that minimum universally accepted principles are essential to ensure both legal certainty and the protection of involved parties' rights.

Firstly, the transformation of international private law principles in the context of smart contracts is critical. The distributional nature of obligations contained in smart contracts complicates the determination of jurisdiction by intertwining the personal laws of participants, decentralized blockchain norms, and traditional legal frameworks. The complexity arises from the convergence of different jurisdictions, which raises challenges such as identifying the applicable law and the place of contract execution (Aleksandrina, 2021; Kirillova et al., 2019).

Additionally, diverse scholarly perspectives indicate that for smart contracts to function effectively within different legal environments, significant reforms must be implemented. Existing legal frameworks often do not fully accommodate the autonomous execution of smart contracts' terms, leading to mismatches with traditional legal principles governing contract law (Турицын et al., 2019; Szabó et al., 2024; Drummer & Neumann, 2020). Certain jurisdictions have begun adapting their legal standards, yet a harmonization of laws at the international level remains scarce (Захаркина & Kuznetsova, 2022; Capocasale & Perboli, 2022).

The legal status of smart contracts continues to be the subject of rigorous academic debate. Some experts argue that a cohesive regulatory framework is needed to mitigate issues surrounding privacy, enforceability, and the integration of smart contracts into existing legal systems (Alhejaili, 2024; Levy, 2017). This includes discussing the implications of their inherent design and functionality, such as immutability and decentralized execution, which may conflict with conventional regulatory mechanisms (Hunn, 2019).

Lastly, the need for reform is highlighted in the context of the United Nations Convention on Contracts for the International Sale of Goods (CISG), which, while providing a uniform legal framework for international transactions, may require adaptations for the effective handling of smart contracts that utilize emerging technologies. Scholarly works stress

that addressing the loopholes in the current legal framework is vital in maintaining contractual freedom and reducing risks associated with these innovative forms of contracts (Zhang, 2022; Ni, 2024). In summary, without structured legal reform and the establishment of international standards, smart contracts risk exacerbating legal uncertainty and jurisdictional conflicts. Universally accepted principles are imperative for protecting the rights of parties engaged in these digital agreements and ensuring their enforceability across borders.

A comparative analysis reveals that various reform efforts focus on aligning national laws with international standards, situating countries within the broader context of legal globalization ("Consequences of Globalization of Law", 2019; Helmke & McLean, 2013). For instance, the systemic integration of international legal norms into national legal frameworks can enhance compliance and support advocacy for common principles essential for effective governance (Kvach, 2021). Furthermore, legal reform initiatives that consider sociopolitical dynamics and stakeholder involvement are likely to be more successful in achieving sustainable compliance with both national and international obligations (Помаза-Пономаренко et al., 2023; Muriaas et al., 2017).

4.2. Theoretical Implications

This research provides theoretical contributions to several legal dimensions as follows:

- Contract Theory: Extends the discourse on how the classical principles of contract (eg: freedom of contract, consensus, and consideration) are tested in a digital context that is automated and without human intervention.
- Digital Legal Theory: Adds a new perspective to the discussion regarding the transformation of legal norms in the face of the digital revolution, especially in the context of self-executing agreements.
- Technology Regulation Theory: Highlights the importance of adaptive, responsive, and collaborative regulatory approaches between government, industry, and academia in responding to disruptive technologies.

4.3. Practical Implications

The findings of this research have several relevant practical implications for stakeholders:

- For Policy Makers (Regulators): Provides a basis for designing inclusive and pro-technology national legal policies, taking into account the transnational aspects of digital transactions.
- For Legal Practitioners: Provides insight into the interpretation of digital contracts and the relevant legal framework, so as to provide accurate and strategic legal advice.
- For Technology Developers: Increase awareness of the importance of legal compliance in smart contract design, including clarity of rights, obligations and dispute resolution mechanisms.

4.4. Comparison with Previous Studies

The results of this research largely confirm previous literature which states that smart contracts have not yet fully gained a place in the traditional legal system. However, these findings also show the existence of progressive developments in several countries, which have not been widely discussed in previous literature.

This research provides validation of the main issues discussed previously—such as enforceability challenges and the incompatibility of conventional law—but also identifies new gaps, such as the need for global principles that have not yet become an international consensus.

4.5. Study Limitations

This study has several limitations that need to be noted:

- Language: Only includes English language literature, so potential contributions from local or regional language publications are not fully accommodated.
- Uneven Distribution of Literature: Not all countries have an equal number of studies or quality of literature, which may affect the geographic representation and generalizability of findings.

4.6. Recommendations for Further Research

To overcome limitations and expand understanding of the legal dynamics of smart contracts, several further research directions are recommended:

1. Cross-Country Empirical Study: Field research that explores the experiences of practitioners, regulators, and users of smart contract technology in various jurisdictions to identify best practices and real-world challenges.
2. Interdisciplinary Studies: Combining legal, information technology and economic perspectives to formulate a more comprehensive and adaptive regulatory approach to digital complexity.

5. CONCLUSIONS

5.1. Summary of Findings

This research shows that there is no single approach adopted by countries in terms of recognition and enforcement of smart contracts. Each country, depending on the applicable legal system, has different interpretations and regulations in dealing with this technological phenomenon. These differences are mainly seen in the way each country defines the legality and enforceability of smart contracts, as well as how this relates to existing principles of conventional contract law. This legal complexity is further exacerbated by differences in jurisdiction which cause inconsistencies in the application of legal rules to smart contracts, which in turn adds to the challenges in ensuring legal certainty and protection for parties involved in smart contract-based transactions. Although legal developments related to smart contracts still depend heavily on the local context and the characteristics of the local legal system, this research also finds an increasing need for international standardization and the application of universal principles that can regulate the use of smart contracts at the global level. This shows the importance of international collaboration to create regulations that are more harmonious and responsive to developments in this technology.

5.2. Contributions to the Literature

This research makes significant contributions in several crucial aspects. First, this research presents a systematic mapping of global legal approaches, covering various jurisdictions, including common law, civil law and hybrid systems. This provides deeper insight into how each legal system responds to smart contract technology innovations, as well as key differences in the interpretation and application of smart contract law across countries. Second, this research offers recommendations for a comparative and adaptive normative framework. This framework is designed to help develop regulations that can address the needs of smart contract technology while providing balanced legal protection for all parties involved. Finally, this research also provides a solid conceptual foundation for interdisciplinary research and public policy, particularly in the context of smart contract technology. Thus, this research not only enriches legal literature, but also opens up space for further studies involving technology, economics and public policy.

5.3. Study Limitations

Some limitations that affect the scope of this study include:

1. Limited geographic coverage, especially since not all countries have sufficient academic publications in English on this topic.
2. Limited access to primary data or internal policies of certain countries, which causes some aspects to only be analyzed based on secondary sources.
3. Variations in the quality and depth of the studies reviewed, so that interpretations of some jurisdictions become more descriptive than analytical.

5.4. Suggestions for Future Research

To enrich understanding and expand the scope of this research, it is recommended that future studies consider:

1. Development of comparative legal frameworks in more depth, especially in examining how smart contracts are integrated in different legal systems, including developing countries and Islamic legal systems.
2. Real implementation case studies of smart contracts in the public and private sectors, to understand technical and legal challenges empirically.
3. Interdisciplinary approach, by involving perspectives from law, technology, economics and sociology, in order to build regulations that are responsive to digital dynamics.

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