

## Legal and Regulatory Aspects of Smart Contracts: A Systematic Review

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<p><b>Article Info:</b></p> <p><b>Article History:</b> Received: October 15, 2023 Accepted: November 25, 2023 Published: December 1, 2023</p> <p><b>To cite this:</b> Omar Farouk Al Mashhour, Ahmad Shamsul Abd Aziz and Nor Azlina Mohd Noor. (2023). Legal and Regulatory Aspects of Smart Contracts: A Systematic Review. <i>Eurasian Journal of Management &amp; Social Sciences</i>, 4(2). doi:10.23918/ejmss.V4i2p156</p> <p><b>DOI:</b> 10.23918/ejmss.V4i2p156</p> 	<p><b>Abstract</b></p> <p><i>As one of the fundamental technologies of blockchain, smart contracts have become one of popular and indispensable for certain businesses. Smart contracts have been introduced by Nick Szabo in 1997. However, the actual implementation was after the introduction of Blockchain, in particular, Ethereum. The enforceability of these contracts has always been dubious due to their unique characteristics and their considerable potential for abuse in criminal activities. The uncertainty stems mostly from these unique qualities and their connection to blockchain technology and cryptocurrencies. Consequently, determining the legal approach governing smart contracts is vital to ensuring the legal validity and the legal viability of such technology. This paper aims to provide a thorough overview and synthesis of prior literature on smart contracts and related regulatory implications (2016-2021). A thorough literature search of Scopus, Web of Science (WoS), Springer, and Emerald was done using two different combinations of key terms: "Smart Contracts AND Legality" and "Smart Legal Contracts AND Regulatory". The final relevant articles were 22 articles found from 2016 to 2021. The narrowing of the literature search shows that smart contracts are a relatively new area that must be legally studied rather than merely focusing on the technical aspects. Ignoring the legal aspect would create uncertainty and inconsistency which might result in various legal dispute due to the nature of smart contracts. the novelty and lack of research represent one of the most major limitations of this research. However, it is crucial to highlight that the number of scientific journals published has increased significantly over the past five years, particularly in 2019 and 2020. This paper offers some guiding principles for academics, legal advisors, practitioners, and policymakers for their future research on smart contracts from a legal perspective.</i></p> <p><b>Keywords:</b> Blockchain, Challenges, Law, Smart Contracts, Regulations,</p>
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## 1- Introduction

Smart contracts are a concept that has been around for more than a decade (Abd Aziz, Noor, & Al Mashhour, 2022). It has been introduced as an idea in 1994 by the legal and technical expert Nick Szabo (Al Mashhour et al., 2022). Szabo defined smart contract as "A set of promises specified in digital form including protocol within which parties perform based on these promises." Szabo came with this idea due to the risk involved in conventional contract and proposed smart contract as a strong alternative that ensure performance and greatly minimize the possibility of any deviations from the contract's rules while also reducing – or even eliminating – the need for trusted intermediaries (De Filippi & Hassan, 2016). Szabo envisioned that such contract would be revolutionary in achieving economic goals of reducing fraud loss, arbitration and enforcement expenditures, and other costs' (Teperdjian, 2020). Smart contract encountered huge transformation in its applicability after the introduction of Blockchain by the paper published in 2009 by Satoshi Nakamoto who presented a strong database where smart contracts can be concluded, executed and cryptographically stored without any risk of manipulation and without the reliance on any third-party intermediary or judicial review (Shin, Kang, & Bae, 2020). Since this merger, smart contracts have gained tremendous attention from corporation and organizations all over the world as it helps new firms in automating tasks which may require less human intervention and fewer intermediaries (Labanieh et al., 2022).

Unlike the research on other discipline, a handful of studies have looked at smart contracts from a regulatory point of view. This was followed by the absence of legislative approaches from the part of countries (Perkušić, Jozipović, & Piplica, 2020, Brownsword, 2019). Therefore, the need for focused regulatory research on smart contracts from many perspectives is particularly critical. The need for a legislative approach is derived from the unique features and characteristics in which it doesn't pair with conventional regulations and legislation, requiring some legislative movement to adapt these changes under the umbrella of the law. Most jurisdictions that have implemented regulatory frameworks in this area have focused on regulating the financial aspects of cryptocurrency-based operations. However, they have not addressed technology legal assurance and validity in order to use this technology while being protected under the law (Ellul et al., 2020). Due to the dearth of legal papers, the key objective of this paper is to examine smart contract literature from a regulatory perspective, given the aforementioned findings, to acquire a broad overview of this relatively new field of research from 2016 to 2021. In the next segment, the

researchers explain the methods used to form the list of journal articles. Also, the researchers analyse to identify the themes of the relevant journal articles and the methods used to analyse those themes. This systematic literature review ends with relevant findings and concluding paragraphs.

## **2 Methodology**

### **2.1 The Plan of the Review**

Firstly, a literature review is a method of gathering and summarising prior research that is more or less systematic (Baumeister & Leary, 1997; Tranfield, Denyer, & Smart, 2003). As a research approach, a successful and well-conducted review establishes a solid platform for increasing knowledge and aiding theory development (Webster & Watson, 2002). A literature review may answer research topics with a power that no one study can match by combining results and viewpoints from a variety of empirical data. In the academic sector, a literature review could be vital for gathering knowledge in a specific field of study. Researchers gauge a full understanding of the issue and its scope, allowing for future study opportunities. The literature review method needs to be more transparent by doing a full content analysis of all connected papers (Khandelwal, Kumar, Verma, & Pratap Singh, 2019). Specifically, the systematic review of literature is a strategy for synthesising a large quantity of data and identifying the major characteristics of a certain topic (Snyder, 2019). As a result, it makes it easier to gather, evaluate, and synthesise data from numerous studies (Macke & Genari, 2019). Under the review plan for this paper, the researcher formed the definition of the review, the aim or objective of the review, and also set the scope for the review. This review plan was adopted from Amos (2018) to achieve a well-developed systematic literature review. This framework for a systematic literature review is illustrated in the figure below.

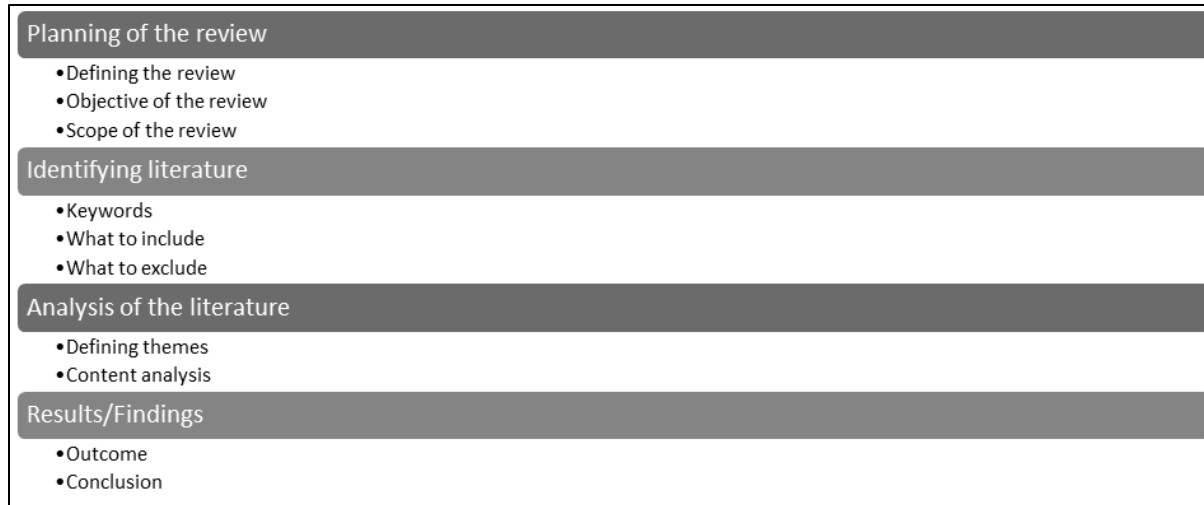


Figure 1 Framework for a Systematic Literature Review

## 2.2 Scope of the Review

A good literature review should have both breadth and precision, which means that it should demonstrate an acceptable method for selecting articles and recording data and ideas, as well as provide more than a list of previous studies (Snyder, 2019). In the vetting phase of the journal articles, the researcher started by searching for journal articles in the selected and relevant databases. The research initiated key word analysis involving two sets of key terms, namely, “Smart Contracts AND Legality” and “Smart Legal Contracts AND Regulatory.” Consistent with Lockett, Moon, and Visser (2006) and Egri and Ralston (2008), the researchers used these keywords to narrow down the search and ensure the relevancy of the area of study. Electronic databases such as Scopus, Web of Science (WoS), Springer, and Emerald were used to conduct the searches, which included a range of legal journal articles. These electronic databases contain high-impact legal journal articles and a variety of publications in the field of legal research.

## 2.3 Identification and Vetting Process of Relevant Literature

In the initial phase, the selected electronic databases produced a high number of results. Further investigation of the result revealed that the inclusion of other types of sources, such as books, book chapters, conference papers, and duplicate journal article listings, in the aforementioned databases significantly increased the number of results. Several variables influenced the screening procedure in order to scrutinise the choice of articles for analysis. These factors include journal article categories, open-access articles, smart contract articles, and legal and

regulatory considerations. This review focuses solely on journal articles; therefore, book chapters, conference papers, and books were omitted following the screening process. The researchers identified 30 journal articles in Scopus, 130 articles in the Springer database, and 123 in Emerald through a systematic and thorough literature identification and evaluation phase. After eliminating duplicates and irrelevant articles, the researchers were left with 22 articles that discussed smart contracts in general and regulatory issues. Figure 2 depicts the data graphically.

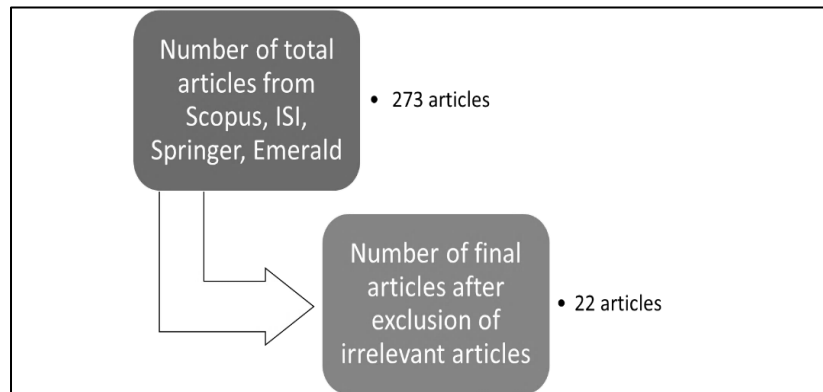


Figure 2 Diagram of the Vetting Process and Selection

In addition, figure 3 shows that there have been very few publications since 2016, with the greatest number of studies occurring in 2019 and 2020. Due to the fact that all of the relevant authors have only one paper on smart contracts and their effects or regulations, it is nearly impossible to determine who the top author is.

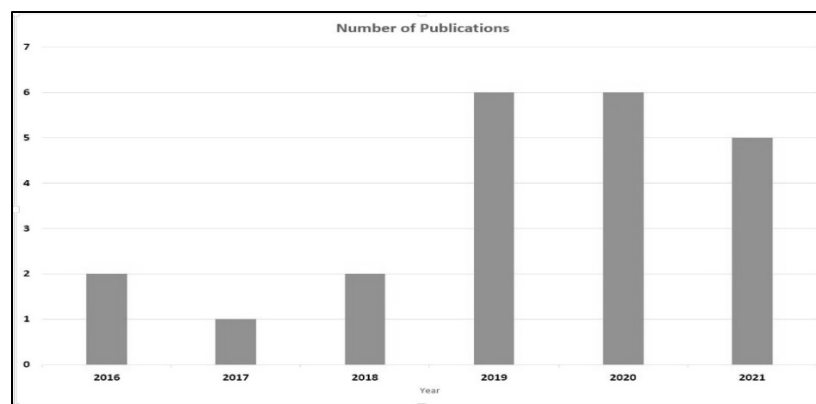


Figure 3 Number of publications (2016-2021)

Figure 4, on the other hand, depict key articles and authors found after the literature search where all author has one score each.

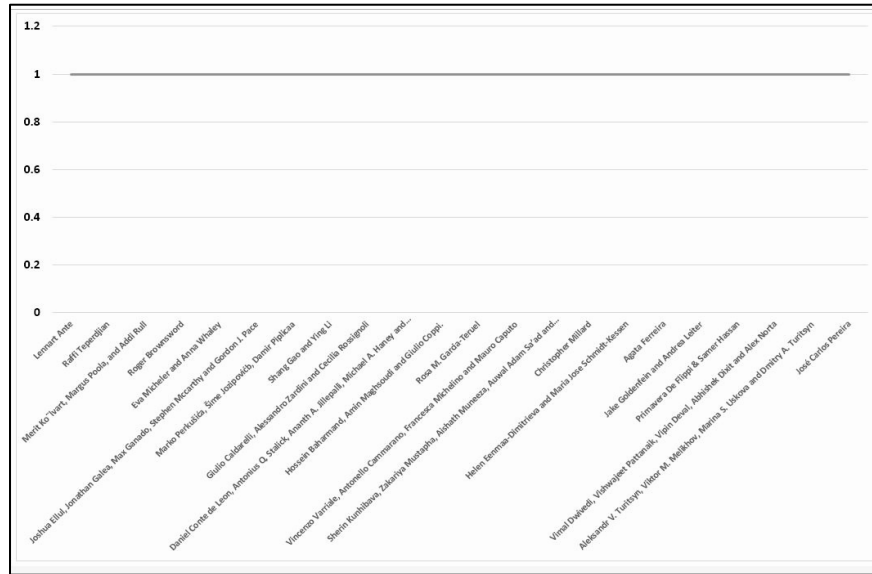


Figure 4 Articles and authors

In general, systematic literature reviews can be used to accomplish a variety of aims. For example, such a review may aid in obtaining the overall framework of a field's structure (De Bakker, Groenewegen, & Den Hond, 2005; Egri & Ralston, 2008; Servantie, Cabrol, Guieu, & Boissin, 2016; Lockett, Moon, & Visser, 2006) and also, literature search determines the impact of various journals (Egri & Ralston, 2008; Lockett, Moon, & Visser, 2006). For the purpose of this study, the researchers aim at answering the following research questions:

1. What are smart contracts?
2. What are the challenges and impacts of smart contracts on the running of the industry?
3. What are the issues identified when dealing with regulations of smart contracts?

After initiating the keyword analysis, the paper titles, keywords, and abstracts were examined for inclusion and conformity with the keyword criteria to decide which papers would be chosen for analysis. When two or more topics related to smart contracts and regulations were discovered, the articles had to be reviewed, particularly the methodology and results, to help us conclude whether the article should be included in this review. Figure 5 illustrates the many themes

identified through our literature search that focused on smart contracts and legal and regulatory issues.

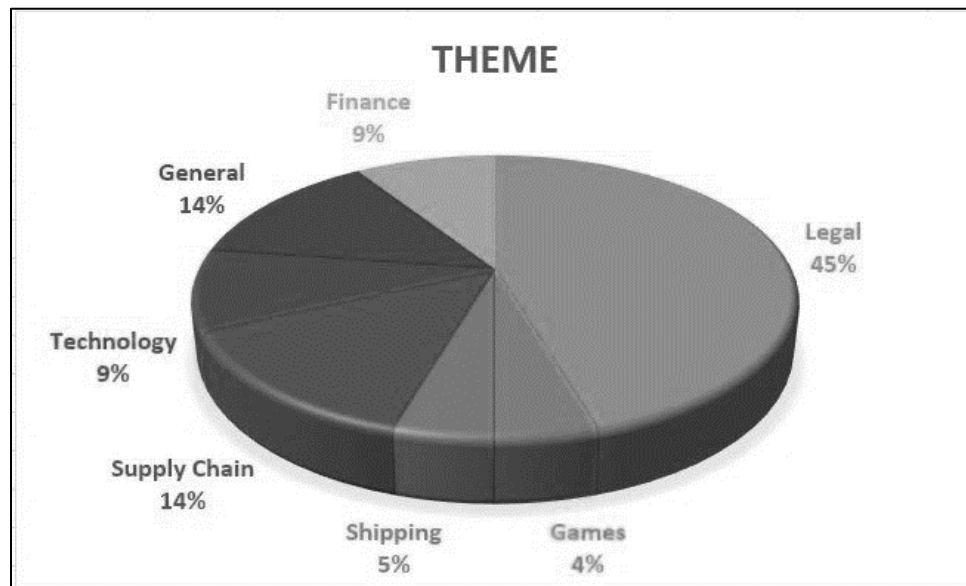


Figure 5 Theme for selected articles

These themes have been derived from the 22 relevant papers. The figure shows that 45 percent of the articles analysed specifically addressed legal or regulatory issues. It also indicates that smart contracts can be analysed from a variety of perspectives, including technology, supply chain, general, finance, transportation, and gaming.

#### 2.4 Analysis of journal articles

During the analysis phase, the researchers selected 22 articles that reflected our emphasis. From the 273 articles located in four databases, the researchers selected 22 as being pertinent. To capture the various characteristics of the studies, all 22 articles were carefully read. The names of the journals, publication year, authors, and dominant themes were implicit in the list of articles. Also, the researchers analysed and separated articles into numerous topics to categorise them into their major emphasis on smart contracts and regulation (general, legal or regulatory, and other themes). As a result, the article selection was finalised to represent the paper's main focus (regulatory perspective). The problems or issues in regulating smart contracts are highlighted in this literature review. They have been praised as a huge technical breakthrough, but they have also been panned as a bad concept. However, their use in the financial sector, government, technology, supply chain finance, shipping, gaming, and general industries has been growing quickly (Ante, 2020). The

discussion over the legal implications of smart contracts has intensified as the use of smart contracts and the variety of smart contract applications have increased, and various legal and regulatory issues associated with smart contracts are being investigated (Baharmand, Maghsoudi, & Coppi, 2021). In this context, due to the diversity of smart contract applications, legal academics have identified legal risks, disputes, and incompatibilities with existing legal frameworks in numerous industries (Ferreira, 2021).

#### **2.4.1 What are smart contracts?**

In this section of the review, the researchers conclude that each of the 22 articles that coined the term "smart contracts" did so from a unique perspective, and that there is no single definition of this term (Turitsyn, Melikhov, Uskova, & Turitsyn, 2019). To illustrate the legal implications and regulations of smart contracts, the researchers first describe the fundamentals of smart contracts, followed by a discussion of their advantages. Next, the researchers delve deeper into the regulatory issues surrounding smart contracts. A smart contract is computer software that autonomously enforces agreement terms without the use of middlemen (Kerikmäe & Rull, 2016). Nick Szabo describes the notion of a smart contract as a vending machine, in which participants engage in an exchange with the seller via a coin, the security of which is guaranteed by a lockbox, or security mechanism (Ferreira, 2021). As a result, smart contracts, can also permit the trade of valuable property via digital means (Dwivedi et al., 2022).

A contract is an agreement between parties that creates a legally binding relationship. Smart contracts are viewed as new types of arrangements that are similar to contracts but written in source code (Goldenfein & Leiter, 2018). A smart contract generally encompasses the software or programmes that are left to run when desired conditions are satisfied, and all members who are involved in these contracts are immediately made aware of the results (Caldarelli, Zardini, & Rossignoli, 2021). It is decentralised and reduces the loss of time on a significant scale. Smart contracts can be made to manage a workflow, prompting actions based on their preceding actions, thus potentially saving time and energy (Roger, 2020). Hence, smart contracts can represent a method of automating certain tasks in addition to their main role of representing an efficient form of contractual agreement. Smart contracts, according to some researchers, do not replace legal contracts; rather, they operate in addition to legal contracts and are used in conjunction with or in addition to legal contracts to provide automated arrangements for certain parts or clauses of a contract (Garcia-Teruel, 2020). Looking at the article reviewed, the researchers were in agreement



that a smart contract can represent a contractual agreement only if it meets the legal requirements of contracts, including their pillars; otherwise, a smart contract would not be considered a form of contract in the legal sense (Merit Kolvart et.al., 2016).

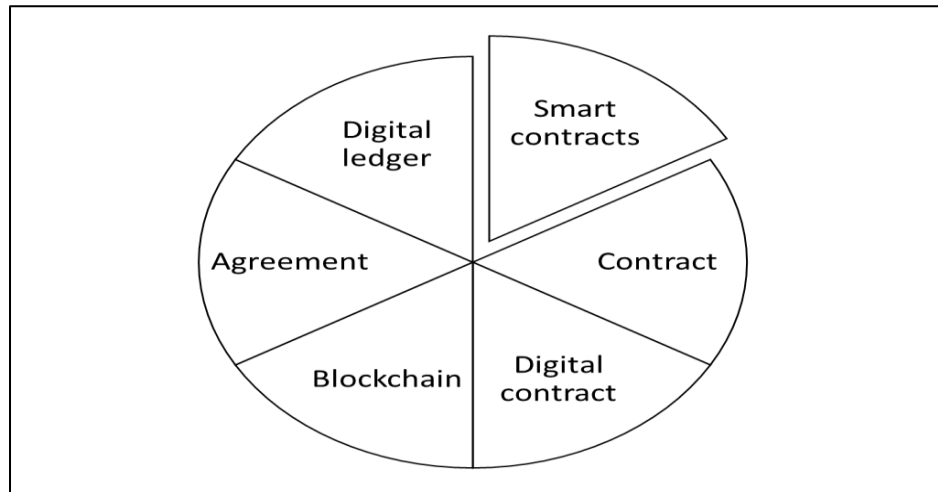


Figure 6 shows some of the keywords generally associated with smart contracts.

#### 2.4.2 What are the challenges and impacts of smart contracts?

In relation to the general articles reviewed, there are certain challenges that stand before the adoption of smart contracts on a larger scale. Prior to market-scale adoption of smart contracts, or Distributed Contracts as a Service (DCaaS), the following challenges must be addressed: ensuring the availability of computational power; ensuring confidentiality and privacy, even in the presence of adversarial actors; ensuring the correctness, security, and trustworthiness of contract execution platforms; and ensuring the correctness and compliance with the rules of governing bodies (Conte de Leon, Stalick, Jillepalli, Haney, & Sheldon, 2017). Apart from the identified common challenges, challenges from specific sectors are seen among the selected 22 articles. One of the sectors is real estate, and the author has also identified common problems with smart contracts. In this context, implementing a real estate conveyancing system through a blockchain causes the following issues: the control of the parties' IDs; the legality of the contract; the verification and protection of rights in rem; the registration of co-ownership; and the amendment of the ledger (Garcia-Teruel, 2020).

The challenges from other sectors such as supply chain, shipping, and finance are analysed. Engagement issues, a lack of technical skills and training, a lack of resources, privacy concerns, regulatory obstacles, pilot scalability issues, and governance hurdles are the main hurdles

(Hosseini, et.,al, 2021). Apart from these hurdles, there are several other legal difficulties identified, such as translation in computer code and complying issues of smart contracts with binding rules in contract law (Eenmaa-Dimitrieva & Schmidt-Kessen, 2018). Focusing on the blockchain, issues relating to smart contracts can be observed from many perspectives such as the adoption of the contract, implementation cost, regulations, governance, privacy, standardisation, and performance of the technology (Varriale, Cammarano, Michelino, & Caputo, 2021). In contrast, the challenges and impact of smart contracts from a shariah perspective are also taken into consideration in this review and the challenges are identified from a few categories: legal, regulatory, and shariah itself (Kunhibava, Mustapha, Muneeza, Sa'ad, & Karim, 2021). Figure 7 summarises some of the identified challenges of implementing smart contracts.

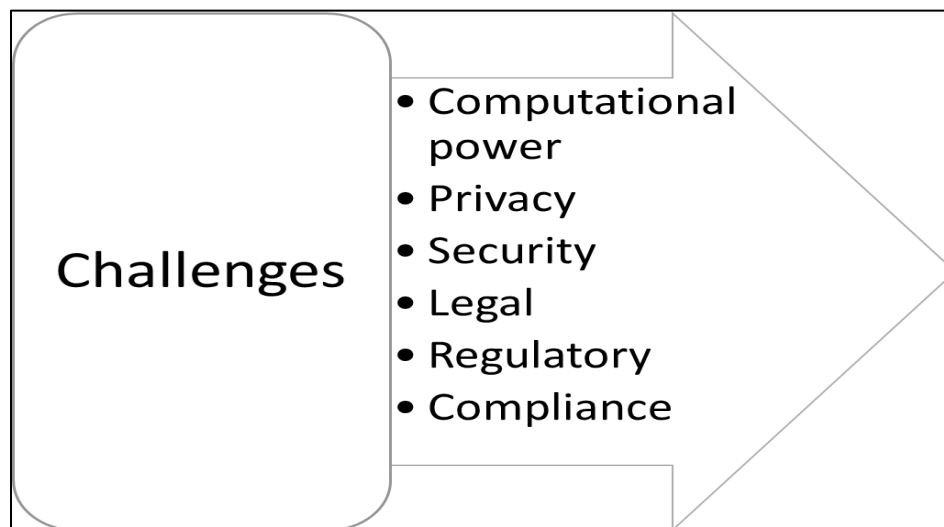


Figure 7: Summary of the Common Challenges

#### 2.4.3 What are the issues identified when dealing with regulations of smart contracts?

Many aspects of life have become digital with the introduction of the Internet. A rapid expansion of Internet resources and space, in particular, revealed new business prospects, contributing to the emergence of breakthrough e-commerce. All of these developments are influenced by the massive demand for Internet services (Aleksandr, 2019). In other words, modern and electronic space allows for a huge number of transactions to be carried out, utilising modern and digital methods. Therefore, the need for proper regulation has become an urgent one. Regulation is crucial in today's world. Regulation is employed to control hazards that contribute to social issues at their most fundamental level (Micheler & Whaley, 2020). It can be applied to a wide variety of fields,

including economics, health, infrastructure, security, and the environment. Authorities impose restrictions on a variety of topics, including smart contracts and their associated activities.

It is essential to recognise that aligning new technology with well-established legal concepts and regulatory structures can be a challenging and time-consuming endeavour. In the 1980s, computer law emerged for the first time, and since then, there have been debates over blockchain technology, demonstrating that regulators continue to acquire information or knowledge from experts in other fields regarding regulations (Millard, 2018). The selected literature for this study demonstrates the potential impact of smart contracts and, hence, the need for a proper regulatory framework in place (Raffi, 2020). Exceptionally, the integration of legal rules into code and the creation of code-based regulation are the two key steps in solving regulatory issues (Gao & Li, 2021). As software governs human interactions, heavy reliance is placed on technology as a decision-making tool and also as a way of enforcing laws directly (Joshua, 2020). Table 2 shows some of the articles that are legal or regulatory, while Table 3 contains other selected articles from other sectors that discuss regulatory matters.

**Table 1 Summary of Literature-Legal/Regulatory**

<i>Authors</i>	<i>Title</i>	<i>Year Published</i>	<i>Overview</i>
<i>Roger Brownsword</i>	Regulatory Fitness: Fintech, Funny Money, and Smart Contracts	2019	Acceptability of Smart Contracts. Application of Law of Contracts to Smart Contract.
<i>Marko Perkušića, Šime Jozipovičb, Damir Piplicaac</i>	The Need for Legal Regulation of Blockchain and Smart Contracts in the Shipping Industry	2020	The potential impact of blockchain technology and smart contracts in the shipping industry.  Existing and expected regulatory reforms of blockchain solutions and smart contracts within the European Union.
<i>Rosa M. Garcia-Teruel</i>	Legal challenges and opportunities of blockchain technology in the real estate sector	2019	Prospective challenges, limitations, and opportunities in the real estate sector and discover how the traditional intermediaries have to face a possible implementation of this technology.
<i>Christopher Millard</i>	Blockchain and law: Incompatible codes?	2018	Identifies conflicts and concerns about blockchain technology vs law.  Discusses Data protection as an area of law that some have claimed cannot be assimilated with blockchain.
<i>Agata Ferreira</i>	Regulating smart contracts: Legal revolution or simply evolution?	2021	Accepts that smart contracts represent the future. Despite posing challenges, there are no major obstacles to smart contracts and accommodate smart contracts within the existing legal frameworks.  Expects a legal evolution rather than a revolution
<i>Jake Goldenfein and Andrea Leiter</i>	Legal Engineering on the Blockchain: 'Smart Contracts as Legal Conduct	2018	The need to link computer transactions to natural language contracts.  Need new mechanisms to address computer transactions, relating to legal tools.
<i>Primavera De Flippi &amp; Samer Hassan</i>	Blockchain Technology as a Regulatory Technology. From 'Code is Law' to 'Law is Code'	2016	Describes the shift from the traditional notion of 'code is law' to the new conception of 'law is code'
<i>Vimal Dwivedi, Vishwajeet Pattanaik, Vipin Deval, Abhishek Dixit, and Alex Norta</i>	Legally Enforceable Smart-Contract Languages: A Systematic Literature Review	2021	Reviews existing Smart Contract Languages (SCL) and identifies properties that are vital to any future SCL for drafting legally binding contracts.
<i>Aleksandr V.</i>	Smart Contract as a New Form of Civil Law Contracts: National and International Approaches	2019	A need for the additional legal regulation of smart contracts, especially in terms of regulating the definition and interpretation hereof.

<i>Turitsyn, Viktor M. Melikhov, Marina S. Uskova and Dmitry A. Turitsyn</i>	to Comprehension and Regulation of the Legal Institution		Any smart contract should be considered as a new form of civil-law contract, but not as a computer code.
<i>José Carlos Pereira</i>	The genesis of the revolution in Contract Law: Smart Legal Contracts	2019	Identifies what revolution Blockchain adds to the contractual processes, exploring its potential and analysing the main legal difficulties it is facing.  Analyses the pros and cons of this new technology, especially the questions about enforcement, nature and form, consent, and (in) flexibility.  Argues that the subject is the beginning of a true technological, social, and economic revolution that must be anticipated and prepared by the law and those who work with it.

Table 3 Summary of Literature discussing the regulatory matters related to smart contracts

<i>Authors</i>	<i>Title</i>	<i>Year Published</i>	<i>Overview</i>
<i>Eva Micheler and Anna Whaley</i>	Regulatory Technology: Replacing Law with Computer Code	2019	Replacing rules written in a natural legal language with computer Code. The use of distributed ledger technology and machine learning software as a regulatory tool.
<i>Joshua Ellul, Jonathan Galea, Max Ganado, Stephen Mccarthy, and Gordon J. Pace</i>	Regulating Blockchain, DLT, and Smart Contracts: a technology regulator's perspective	2020	A framework for technology regulations. The need for technology assurances to be put in place for any safety-critical or high-risk based applications.  Malta Digital Innovation Authority, a world-first regulator of its type, and the innovative technology arrangements framework which currently provides for a technology assurance regulatory environment for Blockchain, DLT, and Smart Contracts.
<i>Shang Gao and Ying Li</i>	An empirical study on the adoption of blockchain-based games from users' perspectives	2021	Develop a research model to examine users' adoption of blockchain-based games.
<i>Giulio Caldarelli, Alessandro Zardini and Cecilia Rossignoli</i>	Blockchain adoption in the fashion sustainable supply chain: Pragmatically addressing barriers	2021	Adoption of blockchain technology, introducing a novel concept of sustainability in the fashion supply chain and its barriers.
<i>Hossein Baharmand, Amin Maghsoudi, and Giulio Coppi</i>	Exploring the application of blockchain to humanitarian supply chains: insights from Humanitarian Supply Blockchain pilot project	2021	Regulatory issue is one of the barriers.
<i>Vincenzo Varriale, Antonello Cammarano, Francesca Michelino and Mauro Caputo</i>	New organizational changes with blockchain: a focus on the supply chain	2020	The benefits, challenges, and future research of blockchain technology (BT) for the supply chain (SC), also suggest how the features of BT can change the organizational aspects of the SC.
<i>Sherin Kunhibava, Zakariya Mustapha, Aishath Muneeza, Auwal Adam Sa'ad and Mohammad Ershadul Karim.</i>	Sukūk on blockchain: a legal, regulatory and Shari'ah review	2020	Explore issues arising from sukūk (Islamic bonds) on the blockchain, including Shari'ah (Islamic law) and legal matters.  The use of blockchain to digitise Sukūk issuing addresses a number of issues. Transactions involving Sukūk have inefficiencies. In fact, structure on a blockchain platform can improve the transparency of the underlying fundamental.
<i>Helen Eenmaa-Dimitrieva and Maria Jose Schmidt-Kessen</i>	Creating markets in no-trust environments: The law and economics of smart contracts	2019	Clarifies and systematize the current thinking on the legal nature and reliability of smart contracts and addressing the concerns of contract law scholars.  Characterizes contracting environments, contract enforcement mechanisms, and the trust relationship underlying contracts.
<i>Raffi Teperdjian</i>	Proposing cybersecurity regulations for smart contracts	2020	Concept of smart contracts while providing the background and context of its development.  Distinguishes smart contracts which are considered legally binding within the scope of US laws from those that may not have legal effect. Talks about the exploitation of smart contracts and explore how the legal reaction to it is inadequate.

### 3.Result and Conclusion

In summary, our research, which is based on the final 22 publications published between 2016 and 2021, presents selected literature on smart contracts and regulatory issues. The researchers identified different themes, and they are technology, supply chain, general, finance, shipping, and games showing the absence of legal aspect. The researchers utilised several methodologies to determine which articles are suitable in the literature. One of the limitations of this review is that the researchers have undertaken our literature search using four databases (Scopus, WoS, Emerald, and Springer). This implies that research published in other publications may form part of our review. Our findings may not cover other international journals about smart contracts and regulations. In light of the fact that smart contracts are essentially transnational, the literature review suggests that international cooperation to tackle this issue is desired.

The review of the previous selected article shows that there is an urgent need for both the government and researchers to make more efforts to tackle the ambiguity surrounding the legal aspect, including increasing the legal-focused research to assist legislators in identifying the best practices, filling in the legal gaps, and avoiding potential risks involved. On the part of legislation, if the legislative efforts are not coordinated, regulatory fragmentation and definitional inconsistencies between jurisdictions may result. The emergence of differing definitions and legal treatment of smart contracts might result in regulatory arbitrage, higher compliance costs, and increased risk for vulnerable contractual parties. In the end, this might inhibit innovation and make it difficult to fully profit from this promising breakthrough. To support innovation, harness opportunities, and integrate technological developments within existing legal systems, authorities should closely monitor developments in smart contracts and intervene where necessary to provide legal certainty, mitigate risks, and protect vulnerable contracting parties. Smart contracts, in many ways, are ground-breaking. It promises to change the way humans interact and businesses operate through their unique features and characteristics. This, however, cannot be seen without a proper and careful observation of the regulatory aspects of smart contracts in order to ensure all the mentioned issues are adequately addressed.

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