Council of Arab Central Banks and Monetary Authorities Governors

Guidance Note on Adopting Smart Contracts and their Legal Enforceability in Arab Countries

Arab Regional Fintech Working Group

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This document was produced under the mandate of the Arab Regional Fintech Working Group (WG) mandate. The WG aims to promote the exchange of knowledge and expertise, strengthen the capacity of the Arab regulators, as well as building a network of Arab and international experts from the public and private sectors to promote the fintech industry and foster innovation.

The "Guidance Note on Adopting Smart Contracts and Smart Contracts Legal Enforceability in Arab Countries" paper was drafted by the following team from KARM Legal Consultants, in collaboration with Dr. Nouran Youssef and Dr. Ali Ben Dob from the Arab Monetary Fund:

Mr. Ishan Pandey	KARM Legal Consultants - Junior Associate & Regulatory Advisor
Ms. Soumya George	KARM Legal Consultants - Principal Associate & Regulatory Advisor
Mr. Manav Joshi	KARM Legal Consultants - Senior Associate & Regulatory Advisor
Mr. Ratul Roshan	KARM Legal Consultants - Senior Associate & Regulatory Advisor

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Executive Summary

This guidance note discusses the advantages of adopting smart contracts across industries. It also focuses on evaluating opportunities, risks and issues for participants and markets arising from the implementation of smart contracts. Further, it explores applying existing financial and civil regulations, laws and norms to smart contract powered-services. Hence, when smart contract applications and activities are carried out outside the regulated environment, some risks currently not covered by existing legislation arise. Smart contract applications' anonymity or pseudonymity and the lack of customer due diligence may enable money laundering, terrorist financing, and other unlawful money-related activities if not adequately monitored. Smart contract-backed services and activities should be regulated and regulatory frameworks must be designed to safeguard consumers, improve investor protection, ensure market integrity and limit illicit financing concerns.

Due to the decentralised nature of smart contract networks and the complexity of the technological innovation involved, it may be difficult to identify people involved in smart contract structures, making current traditional supervision architecture not sufficient. Further, it may be difficult to enforce present restrictions since some arrangements lack an accountable party. Therefore, it is critical for policymakers to lift the technology veil and set standards on when a decentralised smart contract protocol may qualify as an intermediary and who shall be held legally accountable for its operations.

Consumer protection, oversight, and enforcement are all challenges resulting from smart contract administration. For stakeholders, smart contracts come with institutional risks that may impact a nation's market and economic integrity. As a result, stakeholders should be informed of the attendant hazards, such as loss of money, manipulation, technical defects, exploits, thefts, hacking, and loss of cash via user or smart contract mistake or error, which may lead to severe financial loss or have a cascading effect on other industries and services provided by the state.

Even though smart contracts-based financial products are technologically sophisticated, anecdotal evidence suggests that the average user does not completely appreciate the market, exposing them to serious financial risks. Due to the rising tendency toward gamification[1] in the financial markets, stakeholders seeking an alternative to traditional banking may be driven to smart contracts and integrate virtual assets into national economic framework. Therefore, regulators must promote investor protection measures and provide market participants greater guidance on how to convey a product's or service's potential risks to customers. Stakeholders shall support laws and activities that enhance their understanding of such risks to protect themselves against the threats of technology and compliance risk associated with decentralised financial products and smart contracts.

The note draws a set of recommendations for proper adoption of smart contracts, which includes four groups of recommendations: (i) possible remedies to technical challenges, (ii) possible remedies to organizational challenges, (iii) skills development, awareness, and job creation, as well as (iv) managing risks associated with smart contracts.

[1] Gamification in financial markets refers to the addition of features to trading and investment applications that make the user experience more intuitive, exciting, or visually appealing. The purpose is to make trading and investment more fun for the average consumer, like playing a video game. Which in turn, has introduced a new generation of retail investors to financial markets who may not be aware there are few protections in assets like cryptocurrencies.

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1. INTRODUCTION

A more recent contribution of DLT and smart contracts would include the various offerings categorised together as "Decentralized Finance" (DeFi). Decentralized finance is a new and rapidly expanding technology representing a substantial financial service industry advance. As the acronym suggests, it refers to using DLT and smart contracts to disintermediate and decentralise historical financial ecosystems by eliminating the need for traditional financial intermediaries and centralised organisations. Most experts have yet to define a "decentralised" product, service, system, arrangement, or activity. However, it does not matter how "decentralisation" is defined or stated; participants and actions are still subject to the same legal frameworks.[i] Alternatives to traditional financial techniques are the goal of DeFi technology. Many DeFi activities take place on a specific base blockchain (on-chain). However, participants also use other technologies (off-chain) to develop products and systems, communicate, and coordinate activities, such as the internet. This infrastructure consists of internet-based software, collaborative tools, online forums such as Discord, and social media such as Facebook and Twitter.[ii]

The widespread use of blockchain and smart contracts in various financial sector segments (including trade finance, international payments, securities registration, offering and settlement, amongst others) mandates that regulators globally undertake a careful study and analysis of this technology and its implications. Services such as international payments have regulatory requirements to establish the identity of participants as part of Anti-Money Laundering (AML) and Counter-Terrorism Financing (CTF) policies. However, real-world identities are not necessarily required from a purely technical perspective. For example, on Bitcoin, transacting agents (which are not necessarily persons) are only pseudonymously identified with a cryptographic key – though additional verifications may be sought to ensure compliance with AML/CFT laws. Privacy and confidentiality can be challenging when integrating identity information into a blockchain-based system.

This report analyses some of the risks and opportunities arising from the use of smart contracts and the application of blockchain technologies within the financial sector and proposes a few guiding principles for regulators in this regard.

This note is organised around the following main sections: (i) overview of DLT and smart contracts ecosystem, (ii) smart contracts features and various use cases, (iii) interpretation of smart contracts by judicial and regulatory authorities, (iv) remedies for smart contracts, (v) different choices of law and jurisdictions, (vi) advancement in the decentralized online dispute resolution, (vii) study cases for implementation of smart contracts by governments and organizations, as well as (viii) guidance for smart contracts adoption and forward steps. .

1.1. OVERVIEW OF DISTRIBUTED LEDGER TECHNOLOGY

The term "distributed ledger technology" (or "DLT") refers to the protocols and technologies that make it possible for computers on a network to privately suggest, verify, and record modifications to a shared, shared ledger.[iii] Cryptographic and algorithmic techniques are used by blockchain, a type of distributed ledger technology, to produce and validate an ever-growing encrypted data structure in the form of a chain of blocks. This chain of blocks represents the distributed ledger's authoritative record of all transactions.[iv]

It is essential to highlight the difference between a DLT and Blockchain. Blockchain is a type of DLT where each block is linked to the previous block in a linear structure. There are different types of DLTs, such as Directed Acyclic Graph or DAG,[v] where individual transactions are linked to multiple other transactions. For example, IOTA[vi] is a DAG[vii] that uses tangle sequence-based DLT. In DAG, each transaction must validate at least two previous transactions for validation. If blockchain is a chain of a block, a DAG is a tree branching out from different transactions. Therefore, not all DLTs are blockchain, since their block structures, sequences, and consensus processes may vary widely depending on the DLT's design and the organization's final aim and intent.

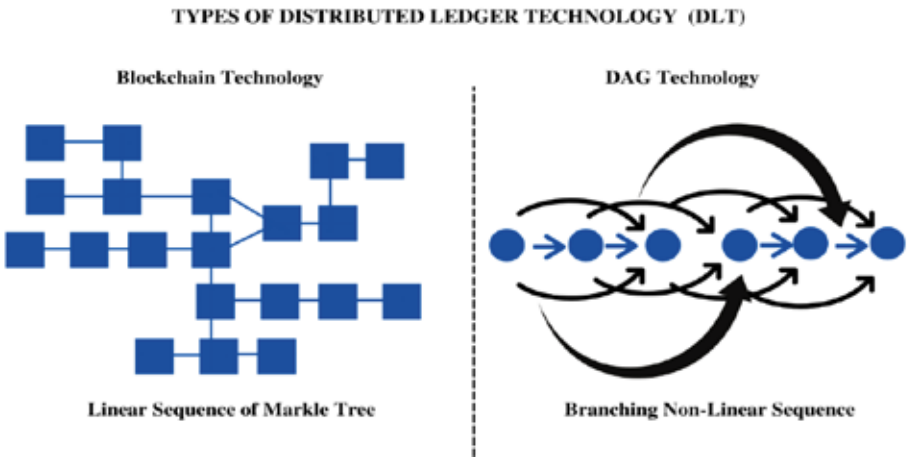

Diagram 1 – Difference between Blockchain & DAG – types of DLT

1.2. HISTORY OF DLT

To develop Blockchain technologies including computers, databases, cryptography, payment mechanisms, and payment systems, and even e-commerce and information networks have all been used. The development of blockchains like Bitcoin and Ethereum is due in large part to the convergence of many different technologies made possible by the expansion of computing power.

Electronic money, also known as digital money, is not a modern phenomenon. E-cash protocols have existed since the 1980s, built on a model suggested by David Chaum.[viii] Through his work, David Chaum used two cryptographic operations, blind signatures and secret sharing, to address these issues.[ix] Ralph Merkle's pioneering hash trees,[x] Lamport, Shostak, and Pease's work on the Byzantine Generals Problem,[xi] which served as the foundation for consensus protocols, Cynthia Dwork and Moni Naor's computing cost invention[xii] and Jakobsson and Jules[xiii] contribution to Proof-of-Work have been fundamental to building the Blockchain of 21st century.[xiv] Proof-of-Work, Byzantine Fault Tolerance, Hash Tree, and the Chain of Blocks are all contributions to computer science that made the development of Blockchain feasible.

1.3. COMMON MYTHS AND MISCONCEPTIONS ABOUT DLT AND BLOCKCHAIN

Even though digital ledger technology is just a decade old, it has already disrupted and reshaped existing business processes worldwide. However, various misconceptions about DLT and Blockchain still exist and are highlighted below:

a) *Myth 1:* Blockchain & DLT is only middleware and does not have execution software capabilities

DLT and Blockchain can be both middleware[xv] and execution software[xvi] depending upon their use and objectives. Next generation blockchains such as Ethereum can execute smart contracts and build decentralized applications on top of the Ethereum network. The Ethereum Virtual Machine (EVM) acts as an execution software that reads and acts based on the smart contract instructions developed in solidity.[xvii]

b) *Myth 2:* DLT eliminates the traditional intermediaries and institutions

DLT may eliminate some intermediaries theoretically. However, due to the existing regulations worldwide, it is particularly challenging to remove intermediaries as their participation enhances market integrity.[xviii] Therefore, although DLT may have the technical capability to eliminate some intermediaries, it does not eliminate traditional institutions and intermediaries. Instead, in its present form, DLT attempts to integrate into existing systems to increase legacy systems' efficiency and effectiveness, which may change the role and function of many intermediaries due to Blockchain and DLT.[xix]

c) *Myth 3:* DLT consumes a high level of energy

Bitcoin indeed consumes much energy, sometimes comparable to small nations. However, Bitcoin uses Proof-of-Work (POW) as a consensus mechanism that requires a significant number of computations to solve a block. Next-generation consensus mechanisms such as Proof-of-Stake (POS), Delegated Proof-of-Stake (DPOS) and Proof-of-Authority (POA) consume a negligible amount of energy compared to Proof-of-Work used by Bitcoin.[xx]

d) *Myth 4:* Blockchains can only be public

Since blockchains such as Bitcoin and Ethereum are public, they have often been portrayed as the only form of blockchain. This statement though is not completely accurate. Besides public and permissionless blockchains, there are also permissioned, consortium, and hybrid blockchains, all of which are distinct from public and open blockchains in terms of their structure, degree of decentralisation, and other underlying rules and regulations. Confidential patient medical records, for instance, must be transferred between institutions via a permissioned blockchain. As the goal of such a blockchain is the secure transfer of medical records, its design must be permissioned so that only authorised institutions, such as hospitals, may join.[xxi]

2. OVERVIEW OF SMART CONTRACTS

2.1. ORIGINS AND CURRENT STATE OF SMART CONTRACT DEVELOPMENT

The term "smart contract" was first used by American scientist Nick Szabo in 1994. He wrote:

"A smart contract is a computerized transaction protocol that executes the terms of a contract. The general objectives of smart-contract design are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimise exceptions both malicious and accidental, and minimise the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitration and enforcement costs, and other transaction costs"

Smart contracts come in different shapes and forms, and they have evolved significantly since Nick Szabo described them for the first time in 1994.

Smart contracts are computer programmes that operate autonomously, in whole or in part, without human involvement. Smart contracts are programmable contracts encoding an agreement between two or more parties that self-execute when defined criteria are met. The transaction's terms are written as a protocol on a blockchain network, meaning they have neither paperwork nor a middleman for validation. The compliance is made through the blockchain's validation process, which is autonomous when the contract's terms are completed.

For instance, parties to a contract may contemplate using smart contracts to automate certain activities inside traditional contracts, such as payment of insurance claims and supply chain management. Smart contracts may also support trade and commerce and peer-to-peer frameworks like the transfer of crypto assets and tokens that represent physical assets, also identified as "off-chain" and enabling "decentralised finance", or DeFi, which intends to disrupt traditional banking and structured finance arrangements.

Smart contracts may be composed of natural language, in code, or a combination of the two. Smart contracts can also be written exclusively in code, which is the most common format. The automation of typical contractual requirements, such as payment terms, may make good use of these tools. It is anticipated that smart contracts would minimise the requirement for contractual parties to trust one another and instead place that confidence in the code.

Concerns remain regarding the situations under which a smart contract would be legally enforceable, how smart contracts are to be construed, how voidable elements like error may be applied to smart contracts, and which remedies will be available if the smart contract does not operate as planned. As smart contracts are still a relatively new phenomenon, there are few and, in some instances, no proven methods for dealing with the legal concerns that arise from the use thereof.

2.2. SMART CONTRACT ECOSYSTEM IN 2021 AND 2022

Decentralized finance (DeFi) is an interactive and multi-faceted commercial system supported by smart contracts and smart contract oracles that replace the existing opaque system based on decades-old technology and practices. It gives consumers permissionless and borderless access to various financial instruments without requiring them to hand up management of their assets to other parties such as brokerage firms or financial institutions.[xxii]

Permissionless networks such as public blockchains are often used for smart contract development for DeFi applications. The difference between DeFi and Centralized Finance (CeFi) regarding how or if the financial service is offered through smart contracts on a blockchain or by a centralised intermediary makes the difference. When compared to DeFi, CeFi depends on the private records of intermediaries, such as centralised exchanges and other platforms, to keep track of contractual and transaction data (i.e., off-chain). DeFi seeks to deliver financial services without relying on centralization. According to its proponents, it digitises and automates the contractual procedures and, as a result, has the potential to reduce intermediary layers and increase efficiency going forward. Users benefit from greater confidentiality than they would get with transactions in CeFi or traditional financial institutions. DeFi platforms and the accompanying crypto assets have seen a surge of interest because of these proposals.[xxiii]

> In order to achieve a decentralised financial system that gives more public accountability and promotes composability across various apps, companies and applications are being created on smart contract frameworks like Ethereum and other Layer-1 networks. Decentralized protocols are being developed for nearly any financial service, including trading, execution, lending, derivatives, loans, event prediction, etc.[xxiv]

There were 428 raises in the DeFi sector so far in 2022, accounting for around a quarter of all investment rounds. According to the data, a little over $1.9 billion was spent on DeFi projects and protocols, with an average and median transaction size of $5.4 million and $2.7 million, respectively.[xxv]

2.3. FEATURES OF A SMART CONTRACT

Smart contracts differ from typical contracts in part or all, as all of the contractual responsibilities are executed automatically by computer programmes, without the need for human interaction.

2.3.1. AUTOMATION

It is necessary to transform or translate a contractual obligation into software code in order for a computer programme to automate the obligation.

Conditional logic is fundamental in a programming language. Thus, contract responsibilities that follow a conditional logic (if X, then Y) are suitable candidates for coding. Automating some of these duties may be possible:

a) The duty to transfer ownership of an asset upon receipt of a given quantity of monies in a certain bank account; or

b) A responsibility to pay money on a particular day or at a specific time.

By automating contractual responsibilities, the parties concerned may save money and increase their productivity. For example, travel insurance pays the insured if there is a delay in the travel plan.

If an insured has a flight delay, they may be required to file a claim under their insurance policy. The insurance company will investigate the claim and make a payout if it is valid. The insurer's duty to pay in the case of a delayed flight might be transformed into computer code if a smart contract were employed. In this case, a worldwide air traffic database might be used as an external data source or "oracle," feeding flight data back to the computer application. The oracle would notify the computer programme of a flight delay, and the computer programme would then make an automated payment to the insurance holder. Computerized claims processing implies that the insured person no longer has to claim with their insurance company and that the payment decision is outsourced to the insurance company and its policyholders.

However, software programs may not be able to automate all contractual responsibilities. These may include requirements that involve discretion, reasonableness, best efforts, or some human judgement. Smart contracts can employ artificial intelligence to make strategic judgments similar to those made by humans. However, the research on artificial intelligence is still in its infancy. There are no real-world instances of it being employed in smart contracts in this manner yet. AI may be able to put more contractual responsibilities into code, but it is unlikely to replace human judgement in the near future completely.

2.3.2. IMMUTABILITY AND IRREVERSIBILITY

As a result of the consensus system, the ledger's data is very challenging to alter. "Immutable" is a term used to describe the data being secure from any mutation or change in records. In the absence of a central administrator, the ledger's immutability implies that nodes may trust its validity and deal with one another in confidence. It is impossible for anybody to "double-spend" a bitcoin because of the immutability of transactions on the Bitcoin network.

In the event that someone tries to spend a bitcoin twice, the ledger (which has an immutable record of the prior expenditure) will reject the transaction as invalid and the nodes will reject it.

3. USE CASES OF SMART CONTRACTS

3.1. DIGITAL IDENTITY

Individuals may take ownership and management of their digital identity via smart contracts, including their reputation, data, and digital assets. Consumers may select what personal information they share with their counterparties, allowing businesses to know their customers efficiently.

Individuals may enjoy a smooth, user-centred internet due to self-sovereign digital identities facilitated by smart contracts.

3.2. SMART CONTRACTS FOR RECORDS

In addition to automating the renewal and release of contracts, smart contracts may digitise the filing procedure. Smart contracts make it possible to automate compliance with requirements mandating the deletion of documents at a later date and commercial code liens that automatically renew, release, or request collateral.

Performance and data security are critical considerations for any smart contract platform that stores data on the distributed ledger. In order to do more sophisticated tasks, lenders and registered agents must be actively involved (e.g. auto- release or automated call for additional collateral).[xxvi]

3.3. SMART CONTRACTS FOR SECURITIES

A smart contract may eliminate the need for intermediaries in the chain of custody of securities and simplify the maintenance of corporations' capitalization tables. An automated dividend, stock split or obligation management may be made possible via the use of a smart contract. Smart contracts may simplify the maintenance of capitalization tables for private corporations while also reconciling record ownership with beneficial ownership of publicly traded shares, decreasing costs and counterparty risk.

In private securities markets, advantages may be reaped more rapidly than in public securities markets. If enabling legislation is needed to specify that a distributed ledger is permitted under Delaware corporation law, the cryptographic signature of the State of Delaware on the ledger entry takes the role of the seal on paper stock certificates. While issuers would appreciate the insight into who holds their securities, certain buy-side entities (e.g., investors) conceal this information.

3.4. SMART CONTRACTS FOR TRADE FINANCE

Accelerated Letters of Credit and trade payment initiation are two ways that smart contracts might help simplify international shipments of products while also increasing the liquidity of financial assets.

Smart contracts allow buyers, suppliers, and financial institutions to mitigate risk and increase finance and process efficiency by automating payment methods and instruments.

For smart contracts to be widely accepted and used, industry-wide standards for contract templates and processes must be created. As a result of probable smart contract execution fallout, the legal ramifications thereof must also be assessed. Settlement systems, off-chain ecosystems and technological requirements (e.g., the Internet of Things) must be successfully integrated to reap the full advantages of a blockchain-based system.

3.5. SMART CONTRACTS FOR DERIVATIVES

Automating smart contracts' post-trade procedures eliminates redundant steps required to record and validate deals and carry out any necessary trade level or other lifecycle events.

The post-trade processing of OTC derivatives may be improved by enforcing a consistent set of rules and conditions for transactions allowed by smart contracts. To provide smart contracts with information from/to the blockchain, it is pertinent for respective oracles to be integrated and governed.

3.6. SMART CONTRACTS FOR FINANCIAL DATA RECORDING

It is possible to use smart contracts to ensure that financial data is recorded accurately and in full transparency for financial institutions. Using smart contracts, financial data may be standardized across enterprises, resulting in enhanced financial reporting and lower auditing and assurance costs. Using such smart contracts, the automation of mortgage contracts may also be possible.

3.7. DECENTRALIZED FINANCE (DEFI)

DeFi, also known as "Decentralized Finance", is a catch-all phrase for various financial activities on distributed ledger technology (DLT) platforms like the Ethereum blockchain. Banks and other intermediaries traditionally administer the conventional financial system, which relies on centralized infrastructure maintained by central authorities. Supporters of DeFi believe it offers a chance to eliminate intermediaries from transactions, including crypto-assets, loans, crowdsourcing, betting, and new types of financial innovation.

4. SMART CONTRACT ECOSYSTEM

4.1. MAPPING PROGRAMMING LANGUAGE ECOSYSTEM FOR SMART CONTRACTS

Blockchains deploy different types of programming languages based on their specific use cases. Programming languages supported by blockchain-based projects have been provided herewith below:

Sr No	Programming Language	Blockchain		
1	Solidity	Ethereum	BNB Chain	Qtum
2	C# & C++	EOS	Stratis	Neo
3	Java & Java Script	Tron	Lisk	Nem
4	Rust	Solana		
5	**Go**	**Hyperledger Fabric**	**Chainlink**	**Neo**

Table 1 –Programming Languages used in Smart Contracts

One of the world's most popular object-oriented programming languages, C# has at least 2 million developers globally. In 2000, C# was first created. It is a popular programming language for creating cross-platform code that runs on different operating systems, including Windows, Macintosh, Linux and Android.

Enterprises may develop their private blockchain systems with the help of Microsoft's Blockchain as a Service provider. Javascript, Java, Python and Go are all supported by NEO, which was created in C# but may be used with a wide range of programming languages.

Programming in Javascript is event-driven, functional, and imperative (i.e., object-oriented and prototype-based). At least 9.7 million people throughout the globe use it as a programming language.

To create apps on top of Lisk's blockchain technology, developers may use Lisk's SideChain Development Kit (SDK), which is an all-purpose programming language with an estimated 4.4 million developers. C++'s biggest strength is its ability to scale resource-intensive projects and allow them to operate smoothly, making it a particularly popular programming language for 3D games.

C++ is also the chosen programming language for EOS because of its ability to execute complex apps on top of the blockchain. Web Assembly-compliant languages are also supported by EOS (WASM).

4.2. VARIOUS FORMS AND MODELS OF SMART CONTRACTS

Smart contracts exist in three distinct forms. Several factors may influence how a smart contract is formed, how it is read, how the parties can be compensated if anything goes wrong, and how quickly it can be enforced.

4.2.1. NATURAL LANGUAGE CONTRACT WITH AUTOMATED PERFORMANCE

Using distributed ledger technology, a piece of code may automate the fulfilment of any or all contract terms are written in plain language. If a user is going to use a code to fulfil its contractual commitments, the user is not going to use the code itself as a record of those duties.

This kind of smart contract has no new legal concerns when it comes to its creation or interpretation. However, if an issue emerges throughout the contract's lifespan and one or both parties seek a solution as a consequence, there may be difficulties. The sort of remedy sought may be impacted by the absence of a way to prohibit code on a distributed ledger from automatically performing any or all of the responsibilities.

4.2.2. HYBRID CONTRACT

Coding and natural language make up a hybrid smart contract. Hybrid contract terms might range from a pure-code contract to one where plain language phrases are used to incorporate elements such as governing law and jurisdiction clauses as well as dispute resolution procedures (e.g., arbitration clauses). As an alternative, the conditions of a hybrid contract might be expressed in normal language with just one or two stipulations written in code.

4.2.3. SOLELY CODE CONTRACT

This is a contract made up entirely of computer code. There is no translation into a language other than English. The parties agree upon the code, which is executed on a distributed ledger per the agreement.

One person may code everything and make the application accessible to everybody with access to a distributed ledger. Initially, it may be prudent to note that this contract is likely to create the greatest difficulties from a contract law viewpoint in terms of identifying whether and when a legal contract is formed and how that contract may be interpreted.

Permissionless blockchain governance allows anybody to join the network and exchange messages with anyone else. Since it lacks a central server, anybody with an Internet connection may use it. Trust in the otherwise dangerous online financial transaction sector was established by Bitcoin, an example of a permissionless blockchain. It secured confidentiality by amassing cryptographic evidence in return for a negligible transaction charge, which aided in gaining users' confidence.

The difficulty with this kind of leadership is that building trust takes a lot of computing power. Less power is required for one-on-one transactions and authentication, and this may be fine-tuned by charging a little charge each exchange. The transaction price might go into the millions of dollars if a group of companies in one nation wanted to utilise blockchain to authenticate a company in another country. As a result, there is a need for advancements in the permissionless blockchain's governance model for dealing with large transactions.

4.2.3.1. NEGOTIATIONS, TERMS AND PERFORMANCE FOR SMART CONTRACTS

The three types mentioned above rely on DLT-deployed computer code to fulfil contractual commitments or simultaneously record and fulfil them. The role of the programming is what separates the three. For example, in the simplest version of a smart contract, a computer program is just responsible for executing plain language contracts. It is used to record contractual commitments and carry them out in the forms of the second and third types of codes.

There are likely to be some practical differences between completing a smart contract and completing a regular contract. Natural language negotiations are expected to be used in many circumstances by parties negotiating the terms of their contract. One way or another, the parties must make efforts to get a piece of software that can record or carry out any number of those contracts' requirements. A DLT system on which that code may be installed, and external data sources or "oracles" that will transmit data to the DLT system to trigger the code's execution, must be designed and configured by the parties.

A third party is likely to be hired if the parties lack the ability to write code independently. For example, the parties might contract with a single computer programmer to design the code based on instructions supplied jointly by the parties. There may be a term sheet or business process document that specifies the transaction, the code's role, and how it will be used upon completion of the code.

On the other hand, the permissioned blockchain governance style adopts a much more centralized approach when compared with its permissionless counterpart. It provides more privacy, as every participant’s role and access are uniquely identified. Permissioned blockchains also reduce the transaction fee cost by establishing rules of transactions between different organizations. Companies like Ripple offer real-time payment options, drastically reducing transaction fees and encouraging companies to adopt its services.

In the event that a party hires their software coder and that coder can engage in the smart contract on the party's behalf, the coder may be deemed acting as an agent on behalf of that party. There is a possibility that a coder may act as an agent for both parties to a contract if the coder has informed approval from both parties.

Every time a deal is achieved, it is necessary to determine when and how it is recorded and whether it is executed as per the local regulations. An agreement combines a written or spoken natural language agreement and a computer-coded programme. It might be more challenging to pinpoint the exact moment the parties have reached an agreement.

When developing new smart contracts, it would be essential to know the most prevalent of the three types of contracts outlined above that are already in use. To better understand how parties negotiate, design, and enter into these smart contracts, we should understand the role of third-party service providers, such as computer programmers and software firms.

4.3. FORMATION OF SMART CONTRACTS

"Smart contracts" are legal contracts that may be implemented automatically without the need for human interaction utilising distributed ledger technology, such as blockchains. To form a legally valid contract, the following conditions must be met:

a) There must be an agreement;
b) There must be a consideration;
c) There must be certainty and completeness;
d) There must be a desire to establish legal relations;
e) There must be formality requirements; and
f) There must be compliance with Sharia or Islamic laws as per the specific requirements.

It is important to note here that each nation may have specific requirements for an agreement to be treated as an enforceable contract. In order for a legally enforceable contract to be formed, there must be an agreement between the parties. Accepting an offer is an acknowledgement that one has agreed to adhere to the conditions set out in it. Acceptance is a definitive statement of agreement with the parameters of a proposal.

Based on the parties' words and actions, an offer and acceptance may be established objectively. It may not be essential to offer and accept in certain situations. For example, it is unlikely that the parties would disagree on whether they have achieved an agreement if they have signed a contractual instrument that embodies the agreed conditions.

Negotiations might take place in language to agree with the parties. The parties would then automatically set up a distributed ledger computer software to carry out some portions of their agreement. These smart contracts do not raise any new legal issues in determining if a contract exists between the parties. The court's job would be to determine whether the parties would have agreed in their natural language conversations. A "hybrid" agreement is likely to clear from the parties' natural language conversations in which normal language and code terminology are used. The parties' natural language talks are expected to refer to and explain the impact of any coded phrases.

Finding an agreement between the parties may be more challenging if there has been little or no use of natural language in the discussions. There are various ways in which parties may engage with each other and perform transactions on a distributed ledger, such as when one party deploys a piece of code and another party interacts with it, prompting the code to execute a transaction. To evaluate if the parties agree, evidence of natural language talks may not be accessible. An agreement between the parties may be based only on their actions in installing and engaging with code on a distributed ledger or the

interactions of programmes deployed by the parties. This raises the issue of whether the parties might have formed an agreement under these circumstances.

4.3.1.1. AGREEMENTS FORMED BY CONDUCT ON BLOCKCHAIN THROUGH SMART CONTRACTS

Illustrative Example:

After receiving 10 Ether from the sender, Ali decides to create Ethereum software to transfer tokens to the sender's account if a certain amount of Ether is received. Ali's computer software is accidentally stumbled upon by Bobrun, a computer, who chooses to engage with it after reading the source code. In order to transfer a token to Bobrun's account, the computer automatically transfers him 10 Ether. Bobrun and Ali do not communicate in the language. The distributed ledger transactions facilitated by Ali's computer software are the only means of communication between them. Is it possible to say that Ali and Bobrun signed an agreement for the transfer of a token in return for 10 Ether from Bobrun?

There are two things to keep in mind. In the first place, we need to determine if Ali made an offer by deploying the computer programme or whether it was only an invitation to offer. An invitation to offer does not imply a readiness to agree to a set of conditions but rather an opportunity to begin a dialogue. The presentation of product sales on a website serves as an example of an invitation to offer. In these cases, the merchant is generally recognised not to be making a binding offer, since the trader may not have the products in-store, they may need to verify the buyer's age before selling the goods, or may desire to protect themselves from having to sell goods that have been mistakenly mispriced. Rather, the trader's goal is to solicit bids from customers, which the trader might accept or reject. By putting the token on the distributed ledger, Ali is only "displaying" the token for sale and simply inviting others to treat him to a cup of coffee or tea.

A lot depends on the context, but not all of them are invitations to offer. There may be an offer rather than an invitation to offer if a website shows digital material for sale that the user may download instantaneously by clicking a box or button on the computer screen.

A similar distinction may be seen between the display of items in a store and in a vending machine, which is typically regarded as an offer the customer can accept by depositing money. The fact that the transaction is completed immediately without additional dialogue between the parties makes these displays seem to be offered to consumers who click the "download" button or enter money into the machine.

If Bobrun accepted Ali's offer of 10 Ether, the second question is whether or not the computer programme received the Ether. Acceptance by deed, it would seem, is what is happening here. An offer has been made whenever the machine's owner indicates that it is ready to accept money. The acceptance takes place when the consumer inserts his money into the slot.

Programming languages that explicitly include the terms "offer" and "acceptance" in their smart contracts might show an agreement between the parties. An example of this is the Digital Asset Modelling Language (DAML), which was built specifically to facilitate the construction of DLT agreements. Ali may use DAML to create an "offer contract" on the distributed ledger that names Bobrun as the "controller." Bobrun, as the offer contract's "controller," has the ability to either accept or reject the deal. As soon as Bobrun accepts Ali's proposal, the offer contract is "archived" on the distributed ledger and a new contract is formed for Ali and Bobrun. Ali's original offer contract, Bobrun's acceptance of the offer contract, and the contract between Bobrun and Ali would all be permanently recorded in the distributed ledger. As a result, a court might use DAML and other comparable programming languages

to track the development of a smart contract on a distributed ledger and pinpoint the exact code that represents the parties' agreement.

4.3.1.2. AGREEMENTS DEPLOYED BY PARTIES BUT DEVELOPED BY SOFTWARE PROGRAM

A human's actions may affect the outcome of an offer and acceptance, as we have seen in the situations above. An offer and an acceptance have been shown in the case of the deployment on a distributed ledger of a computer programme and the subsequent interaction with that programme (such as the transfer of bitcoin to the programme). However, in other situations, the offer and acceptance may be carried out by computer programmes deployed by the parties without involvement. Computer programmes on a distributed ledger may interact with one another and result in a transaction between Ali and Bob. Because of the use of computer programmes, it is not clear when (if ever) the parties involved in this circumstance may be determined to have come to an agreement as a consequence.

In theory, creating a contract using a computer program is possible. For example, a contract involving computer software automatically establishes insurance contracts between insurance agents and insurers. As soon as an insurance broker enters the information of a necessary insurance product into the software, an offer of insurance is instantly generated on behalf of the insurer. Because the 'qualifying criteria' of the insurer had been explicitly written into the software, an insurance offer created on their behalf could be made without their involvement. To accept the insurance broker would then have to take a series of steps inside the programme. The software might automatically issue an insurance policy for the insurer.

4.4. AGREEMENTS EXECUTED ENTIRELY THROUGH A SMART CONTRACT

Using a distributed ledger, the parties may be able to come to an agreement based only on their actions. When Ali offers to sell a token to Bobrun through the deployment of a computer programme, Bobrun accepts an offer by paying bitcoin to the programme, as shown before. In addition, the parties might come to an agreement by deploying computer programmes on a distributed ledger and having them run automatically.

Only 'explicit' agreements, i.e., agreements expressed verbally or in writing, are presumed to have the effect of creating legal relations. Rather than relying only on their words, Ali and Bobrun come to an understanding based on their actions, rather than their words. That being the case, the presumption in favour of legal connections may not be applicable. If the agreement is being enforced, the burden of proof is on the party making the enforcement request.

If it is required for the transaction to have "business reality," or if the parties would have anticipated "enforceable duties to exist," courts may enforce agreements based only on their behaviour.

Transactions on a distributed ledger may or may not indicate a desire to establish legal ties, depending on the expectations of individuals using a certain DLT system. A DLT system's users may understand that transactions on the ledger do not constitute legally enforceable obligations, which might be a disincentive to establishing legal ties. Similarly, it may be claimed that when assets are transferred in return for payment, it is a typical situation in which parties want to create legal duties.

Some agreements on a distributed ledger may be better described as explicit agreements rather than agreements inferred from the parties' actions. Bobrun could accept Ali's piece of code if he offered it, as shown with the DAML programming language before. The distributed ledger agreement would be represented by Ali and Bobrun's code submitted and accepted. Since Ali and Bobrun have agreed to

anything in writing, the assumption that they intended to form a legal relationship may apply to their code. Words may well be represented or reproduced in code. It is thus possible to describe a code-only agreement as an explicit agreement, which is an agreement articulated in words.

4.5. SMART CONTRACT-BASED LEGAL CASE STUDIES FOR ARAB NATIONS[2]

4.5.1. UNITED ARAB EMIRATES (UAE)

The UAE's Civil Code organizes and regulates all civil rights and duties, including contractual arrangements. A number of other rules and regulations and the Civil and Commercial Codes deal with the efficacy and legality of certain sorts of contracts, such as land transactions and ship sales.

The civil code, founded on Islamic law principles, distinguishes between fundamental aspects that determine whether a contract exists as opposed to being invalid and less fundamental matters that impact the contract's binding force but not its existence.

The following are the fundamental factors for creating a contract under the Civil Code[xxvii]:

1) Mutual agreement on the contract's fundamental elements;
2) an acceptable subject matter that is possible and defined (or capable of being defined); and
3) a legitimate cause or purpose for the contract's responsibilities.

When determining whether or not a contract has been created, the courts will usually look at the surrounding circumstances, especially if there is proof of offer and acceptance, clarity of terms, and each party's capacity to contract.

A contract made for an unlawful purpose or whose subject matter violates public order or morality, for example, is invalid. The absence of legal capacity does not automatically render a contract invalid and unenforceable, unless the law specifically prohibits or severely limits contract formation by the incapacitated party, or the lack of capacity leads to the exploitation of or conspiracy against the incapacitated party.

Verbal contracts are prima facie enforceable in the UAE. The enforceability will be determined by the parties' conduct, such as whether they have indicated intent to contract and/or whether they have agreed on the contract's basic elements.

Documents that have been notarized give confirmation of their legitimacy. Certain types of agreements, such as commercial agency agreements that must be registered with the UAE Ministry of Economy and contracts purporting to transfer real estate, must be in writing and notarized in order to be valid.

4.5.2. KINGDOM OF BAHRAIN

Under the Bahrain contract law, the requirements for the formation of a legally binding contract are as follows: (1) offer; (2) acceptance; (3) consideration; (4) intention to create legal relations; (5) consent; and capacity to contract (above 18 years).

[2] Arab countries are listed in their alphabetical order of the League of Arab States.

According to Article 127 of the Bahraini Civil Code, a contract is not limited to the contracting parties' responsibilities to do what is specified explicitly in the contract but also includes those obligations ancillary to it arising from the law, custom, or nature of the transaction. The responsibility of good faith entrenched in the language of Article 129 of the Bahraini Civil Code is an auxiliary obligation placed by law on contractual parties.[xxviii] Policymakers in Bahrain may have to explore mechanisms to bridge the gap between the execution of a smart contract and its legal framework.

4.5.3. KINGDOM OF SAUDI ARABIA (KSA)

Shari'ah principles primarily control commercial contracts in the Kingdom, often worded in broad words and provide Saudi Arabian adjudicating agencies with much leeway in applying them. The most common Shari'ah principle governing contracts in the Kingdom is that the parties to a contract must uphold their contractual obligations unless the counterparty waives them, they are excused for a legitimate reason under Shari'ah, or they are found to be in conflict with Shari'ah principles, enacted legislation, or public policy.

The overarching principle contained in the maxim "The Contract is the Law of the Parties" (Al Aqd Shari'at Al Muta'aqdin) has become accepted under Hanbali law, which means that, in general, the parties to a contract are free to agree to the terms of their choosing, as long as these terms do not conflict with established Islamic Law principles. The "law against gharar," which states that contracts must be devoid of doubt, is a fundamental tenet of Islamic Law.[xxix] Policymakers in KSA may have to explore bridging the gap between the execution of a smart contract as per its legal framework.

4.5.4. THE SULTANATE OF OMAN

Under the Oman contract law, the requirements for the formation of a legally binding contract are as follows: (1) offer; (2) acceptance; (3) intention to create legal relations; and capacity to contract fully having his mental faculties and is not declared incapacitated. [xxx]

Not only are written agreements acceptable in Oman but so are spoken agreements. As a result, a contract is considered to exist when two parties exchange the desire to execute particular activities for one other. Their agreement is not nullified by the fact that they have not written down their separate responsibilities. Policymakers in Oman may have to explore mechanisms to bridge the gap between the execution of a smart contract and its legal framework.

4.5.5. ARAB REPUBLIC OF EGYPT

Contracts in Egypt are not required to be written in a specific format. It does, however, require that the contract be written and have the essential contractual elements, such as legal capacity (above 18 years), offer, acceptance, compensation, and the desire to form a legal relationship.

In several cases, Egyptian courts have recognised online contracts formed by one party accepting the other's offer by email, texting, or by one party clicking a link that implied approval of the terms and conditions.[xxxi] Policymakers in Egypt may have to explore bridging the gap between the execution of a smart contract as per its legal framework.

5. INTERPRETATION OF SMART CONTRACT BY JUDICIAL AND REGULATORY AUTHORITIES

5.1. IDENTIFICATION OF TERMS

Natural languages like English have evolved within more or less organic linguistic communities from human prehistory to the present day. Formal computer languages, such as C++, are much more recent and were created to program deterministic agents and allow communication between members of human society (i.e., machines that ultimately follow a binary logic encoded in transistor states). Natural and formal languages include structured, symbolic content, but they differ in key ways.[xxxii]

However, this bifurcation of natural and coded languages has given rise to interpretative issues within the judicial and legislative realms of smart contracts. Despite being seemingly self-performing, disputes regarding the interpretation of different clauses of smart contracts have not eluded the general public. The general trend in contractual interpretation suggests that when interpreting a contract, a judge tries to figure out what the parties intended whilst also referring to what a reasonable person with all of the contextual information available would have interpreted the contract language to entail.[xxxiii]

A judge's role while interpreting a smart contract is to ascertain what the parties objectively envisioned as their obligation. When code is concerned, part of the process will determine whether the code or a portion thereof was meant to establish the obligations or merely carry them out.[xxxiv] Since smart contracts will almost always involve natural language negotiation and usually some natural language terms,[xxxv] a clear and decisive expression of intent may be necessary to interpret terms effectively.

Parties intentions on the role of the code in smart contracts could be deduced from the natural language terms. To illustrate, parties being prepared to expressly agree that the natural language terms form the parties' "entire agreement". Such a clause would make it apparent that the parties intended their agreement to be written in normal language, with the code serving only to automate the agreement's execution.[xxxvi]

For seamless identification of terms within smart contracts, the express indication of intent in natural language terms is necessary. The lack of safeguards mentioned above may give rise to disputes concerning the evaluation of intent of the parties involved within the contract in question.

5.2. DISPUTES REGARDING CODED TERMS

A dispute over understanding natural language terms in a hybrid smart legal contract may develop. What the coded terms "mean" may be crucial to the court's interpretation of the natural language terms in question. Where the coded terms of a smart legal contract clash with other conditions of the agreement, disputes concerning the right interpretation of the coded words are likely to emerge. When parties express a word in both natural language and code without indicating which term takes precedence in the case of a conflict, issues concerning coded terms are likely to arise.[xxxvii]

To aid the court in resolving conflicts between coded and natural language words, the natural language element of a hybrid smart legal contract may include a term establishing an order of priority to handle such conflicts.[xxxviii] That performance of the coded terms of a smart legal contract could not always be predicted based on a reading of the code, most consultees thought that performance of the coded terms could not always be so predicted.[xxxix] Variations in code performance and reading could be attributed to "unforeseen, unintended alterations by third parties such as hackers," according to Dr Robert Herian.

Due to errors or bugs in the code, the execution of the code might not be predictable based on a reading of the code, according to Dr Sara Hourani and Hendrik Puschmann.[xl]

As per the analysis, disputes regarding coded terms of smart contracts in the instance of inconstancies of performance are an unavoidable reality that needs to be remedied. The remedy for such disputes may be a clear, objective and indisputable expression of intent from both parties. Reference can be made to the 'Recital' section of traditional contracts through which both parties' intentions are clear and is considered to be a reasonable guide towards ascertaining the context under which the contract in question was made. Such context would also include the relationship between the parties and why the agreement was made in the first place.[xli]

5.3. Reasonable Coder Test

There are two avenues for ascertaining the meaning of a coded term in a smart legal contract, other than asking what a reasonable person would understand the coded term to mean. The approaches are:

a) asking how the coded term would be understood by a functioning computer; and
b) asking what a person with knowledge and understanding of code would understand the coded term to mean.

The most appropriate test would be that of a person with knowledge and understanding of code – that is, a "reasonable coder".[xlii] Coded phrases can be amenable to contractual interpretation.[xliii] Although determining the meaning and purpose of code can be challenging, it is recommended that the "reasonable coder" test should be used: ask what a person with expertise and understanding of code would think the coded term means. The "reasonable coder" standard is more compatible with the existing approach to contractual interpretation than questioning what the code meant to a working machine. Expert coders could help the court with its inquiries in the same manner that a translator can help the court read a contract written in another language.[xliv]

5.4. Natural Language Aids

Where the smart legal contract includes coded terms, the parties should include a natural language explanation of how the code works. An explanation of the parties' intentions will be important if the code operates in a way that the parties did not anticipate or intend.[xlv]

Parties might include "explanatory addendums to coded terms such as logic maps or process flowcharts to assist with setting out the agreement for how the code should work".[xlvi] The commercial natural language should always be used to capture the contract as a whole, with coded terms sitting 'underneath' agreed terms or processes that are suitable to be automated. However, this does not mean that the coded components do not form part of the contract – instead, like notice provisions, they provide detailed and/or technical instructions about how performance should be conducted, which can be treated as essential or non-essential depending on the preferences of the parties.

To ensure a natural language explanation of the code is taken into account when interpreting coded terms, the parties could expressly state that such explanation forms part of their legally binding agreement.[xlvii] This cannot be done merely through an explanation clause, as any explanatory note constitutes evidence of the parties' subjective declarations of intent or previous negotiations. It will be inadmissible for contractual interpretation.[xlviii] By using recitals, the drafter explains to the reader the parties' relationship and why they entered that agreement.

5.5. Implied Terms

It may be difficult to prove an implied term where the parties have stated some or all of their smart legal contract terms in code. An implied provision exempting a party from performance when "an oracle abruptly begins delivering incorrect data." A term that releases a party from performance if an operator provides erroneous data is likely to be judged reasonable in a primarily coded smart legal contract. However, reasonableness is not the essential criterion for finding an implied term.[xlix] How a smart legal contract based only on code could be regarded to be "lacking commercial or practical coherence" if it did not include a phrase exempting a party from performance if an oracle provides erroneous data. The code's behaviour is likely to be a significant indicator that the agreement is coherent and full by its very nature.[l] Unfortunately, no reliable sources exist for genuine recommendations from the judicial or legislative perspective.

6. Remedies for Smart Contracts

A smart contract written entirely in code is immune to contractual interpretation, partly because interpretation entails assigning meaning to normal language, and partly because code is generally straightforward, unambiguous, and self-contained. On the other hand, smart contracts do not need to be classified as a distinct type of contract to which the regular rules of interpretation do not apply. Rather, a smart contract composed entirely of code and including no natural language elements might be viewed as an extreme example of a contract whose language is explicit, with no rationale for deviating from it.[li]

6.1. Vitiating Factors

The smart legal contracts formed by the autonomous interaction of the parties' computer programmes have no fundamental revision to the existing rules of unilateral mistakes required. However, smart legal contracts will create new legal challenges in evaluating whether a party was led to enter into a contract by the other party's misrepresentation.[lii]

A smart legal contract that is voidable owing to misrepresentation, coercion, or undue influence may seek rescission of the smart legal contract, as existing legal rescission concepts can be easily applied to smart legal contracts, as agreed by a majority of consultees.[liii]

The blockchain itself could not be amended to reverse the effects of the code’s performance. It did, however, provide alternative methods for the court to accomplish "practical justice" between the parties.[liv]

6.2. Frustration

Existing frustration principles may accept smart legal contracts, despite the fact that they may result in new sorts of frustrating events. Even though the courts may have to "consider a number of new and different supervening events (for example, the failure/closure of a third-party platform)," Herbert Smith Freehills remarks that "there is no reason the basic grounds for frustration" cannot apply to smart legal contracts.[lv]

The frustration-inducing event may not prohibit the code from running, but it may force the code to run in a "fundamentally different" way than the contract specifies. The doctrine of frustration may theoretically be used in these instances. Alternatively, as with traditional contracts, a subsequent change in the law could make something that was expected under the smart legal contract legally impossible.

Under the law of unjust enrichment, the parties may attempt to recover benefits that continue to be granted by the code after the discharge of the frustrated smart legal contract.[lvi]

A smart legal contract is frustrated because of the physical impossibility of performance. Termination of the contract and subsequent performance of the code becomes less of an issue. The external incident will have rendered the code physically unable to execute. Any further execution of the code will need to be terminated if the smart legal contract is frustrated owing to an external event rendering performance of the code legally impossible or fundamentally different from what was intended under the contract.[lvii]

6.3. RECTIFICATION

Rectification may be achieved when the apparent intention of a coded term differs from the common intention of both parties.[lviii] The first category of rectification involves situations in which the parties intend for the written contract to reflect the provisions of a prior contract, but the written contract fails to do so due to a drafting error.[lix] This type of rectification has a limited reach and therefore is rarely invoked in typical contracts.[lx] It is possible that it will happen more frequently in the context of smart legal contracts. This is because smart legal contracting may entail the parties first signing a contract in natural language that spells out the transaction's parameters. If the code contains contractual phrases that are meant to mirror the terms of the natural language contract, the code may be corrected if those natural language terms are not reflected.[lxi]

In the context of smart legal contracts, correction based on a shared intention may be an appropriate remedy. The parties may first agree on the details of their agreement via natural language negotiations, and then hire a coder to convert the agreement into code. When a deal is translated from natural language to code, there is a risk that the code will not accurately reflect the parties' objectives. Proof of the parties' subjective intentions as to the meaning of the terms used, including evidence of their past negotiations, is not admissible.[lxii]

In circumstances where the code has already been fulfilled fully in terms of providing a foundation for the award of other remedies, such as breach of contract, affirms that rectification may still be appropriate.[lxiii] To do so, the court may need to interpret the "meaning" of the coded terms in order to determine that their meaning is apparent and that the coding error is part of the contract.[lxiv] Compared to traditional contracts, we expect rectification arguments to be more common in smart legal contracts. This is due to the fact that translation problems are more likely to be discovered after the code has (partially or entirely) executed.[lxv]

7. CHOICE OF LAW & JURISDICTION

The jurisdiction provision in a contract states the courts or arbitration panel that will have exclusive or non-exclusive jurisdiction to hear any disputes arising out of the contract, whereas the governing law clause lists the laws that will govern the relevant contract. These provisions are sometimes tacked on as "boilerplate" language at the end of contracts, making them easy to miss throughout the writing process.[lxvi]

These provisions, however, need just as much consideration as the contract's main body text. Failing to agree on or include appropriate governing law and jurisdiction provisions may lead to protracted and costly disputes about the applicable law and dispute resolution processes for a specific contract. This is a worrying development since it might lead to inconsistent application of the law and the possibility of "forum shopping," in which the contractual parties bring the same dispute before many different courts and tribunals.

7.1. THE SUITABILITY OF THE CHOSEN LAW FOR DETERMINING ANY FUTURE DISPUTE

For greater legal certainty, parties to international commercial contracts will often rely on the law of certain jurisdictions, such as England or New York, where there is a substantial body of sophisticated case laws dealing with issues which arise in conflicts over commercial or financing contracts. Many of these business difficulties may be unresolved by the laws of other countries, and in other situations, such laws may not even recognise principles that are important to the contract. Instead than focusing on the law of the place where the parties are physically located, they should consider what law would be most appropriate given the circumstances.[lxvii]

7.2. PARTIES SHOULD CONSIDER THE JURISDICTION THEY HAVE SELECTED FOR THE RESOLUTION OF ANY DISPUTE

To simplify matters, parties often agree on the law of the jurisdiction they want to apply to the issue. For instance, a contract may designate English law as the controlling law if the parties agree to submit to the exclusive jurisdiction of the English courts in the event of a disagreement. This need not always be the case, though. Some legal systems' courts are quite experienced at incorporating foreign law into cases they have jurisdiction over. It is important for the parties to keep in mind, however, that if they do not agree on what the foreign law is, the burden of proof will shift to them. It's also important for the parties to know that certain national courts may actually ignore the choice of law provision. It is also important for the parties to examine the possibility that the courts of the nation whose law they have selected would implement it in a way that is at odds with the parties' expectations. Arbitration is another option that might be agreed upon by the parties. Modern international courts are adept at applying the laws of a variety of jurisdictions to conflicts of this kind; in fact, arbitrators are typically chosen for their knowledge with or competence in the law of a specific country.[lxviii]

7.3. FAMILIARITY OUGHT NOT TO BREED CONTEMPT

Rather of trying to find a happy medium by agreeing on a "neutral" statute, the parties should choose one they are already acquainted with. If a disagreement arises between the parties on the meaning or application of the contract, the latter option might lead to unpleasant shocks.

7.3.1. GOVERNING JURISDICTION CLAUSE

A typical jurisdiction clause will provide:

"The parties submit all their disputes arising out of or in connection with this agreement to [arbitration] [or] [the exclusive] [non-exclusive] jurisdiction of the courts of [the country]."

The primary concern is deciding whether to resolve any contract problems via arbitration or litigation. When compared to litigation, arbitration in international contracts has a number of benefits, including: the capacity to enforce judgments under the 1958 New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards; the finality of decisions (there are no appeals for arbitration decision); the opportunity to pick the arbitrators (although this is not always the case); the privacy of processes; and the finality of the result.

7.4. ENFORCEABILITY OF JUDGMENTS

Any judgement must be able to be collected from the defendant's assets in order to be effective. A party seeking protection for its interests may therefore opt for the country in which the other's assets are situated, unless the judgement can be enforced in other jurisdictions under the terms of international treaties or conventions on the recognition and enforcement of judgments in civil and commercial matters. Drafting a proper jurisdiction provision is crucial to guarantee recovery, which is just as vital as obtaining a favourable judgement or award.[lxix]

7.5. PROCEDURAL ISSUES

The parties should consider other procedural issues in their choice of court, including:[lxx]

- Whether it is practicable to litigate in the language of the chosen court.
- Whether the chosen court will actually apply the governing law of the contract.
- The speed and procedural flexibility of proceedings in the chosen courts.
- The suitability of remedies available from the courts of the chosen country, including interim and provisional measures.
- The finality of judgments in the chosen jurisdiction.

7.6. USE OF AN ARBITRATION INSTITUTE

Many arbitration agreements will also specify the arbitral body that will be in charge of the process, in addition to the jurisdiction and the laws that will be applied. The United Arab Emirates (UAE) is home to a variety of reputable organisations, such as the Dubai International Arbitration Center (DIAC), the Dubai International Financial Center (DIFC)-LCIA Arbitration Centre, and the Abu Dhabi Commercial Conciliation and Arbitration Center (ADCCAC). But the parties are free to utilise the rules and/or facilities of other organisations, such as the International Chamber of Commerce (ICC) in Paris, the London Court of International Arbitration (LCIA), or the Singapore International Arbitration Centre (SIAC).

The parties should pay serious consideration to the selection of an arbitration institution when structuring their contract since it can aid in the efficient and successful management of any future arbitration. Based on these merits, we advocate for the widespread adoption of arbitral institutions.

7.7. UAE: A CASE STUDY ON LEGAL ENFORCEABILITY

This research has so far made the assumption that most national courts would accept governing law and controlling jurisdiction terms. Some challenges may arise, albeit this is not always the case.

The UAE courts will not uphold an agreement which gives jurisdiction to a foreign court where the UAE courts would otherwise enjoy jurisdiction. This includes disputes involving:[lxxi]

- the ownership of properties situated within the UAE
- Proceedings involved a transaction that was made, formed or supposedly formed in the UAE
- An event occurring in the UAE.

Moreover, the UAE will not accept and recognize jurisdiction clauses, which provide for a foreign court or arbitration tribunal to determine disputes, which involve:[lxxii]

- Commercial agencies
- Employment
- Certain real estate matters connected to the UAE.

Furthermore, where the UAE courts have jurisdiction, they will usually apply UAE law instead of the governing law chosen by the parties. Conflict issues may arise within the UAE legal system itself with regards to the allocation of jurisdiction between UAE courts depending on the subject matter of the agreement, which requires careful consideration.

Legislation is passed at both the federal and emirate levels in the UAE, which has a multi-layered legal system. Additionally, the UAE is home to a large number of free zones that are unique economic zones with their own legislative bodies. For the purposes of this guide, we have taken into account both the position in the two special financial Free Zones – the Dubai International Financial Centre (DIFC) and the Abu Dhabi Global Market (ADGM) – as well as the position that applies to the UAE generally (i.e., outside of the Free Zones, which we refer to in this Guide as Onshore). The UAE Onshore legal system, which is heavily inspired by Egyptian law and reflects the fundamentals of Islamic Shari'ah law, is a Civil Code system, unlike the DIFC and ADGM, which are based on English Common Law. Onshore, in the DIFC, and in the ADGM, there is no universally accepted definition of what constitutes "writing" in the context of written legal assertions. [lxxiii]

Onshore, the UAE Federal Law Number 5 of 1985[lxxiv] on Civil Transactions Law (the Civil Code) sets out a number of contracts where a written form is required. These include:

- sale and purchase of immovable property;
- partnerships;
- marriage; and
- life annuities.

Writing is not a prerequisite for the creation of a will, but a court will only consider a case involving a will if it is in writing and signed by the testator. Additionally, even while there may not be a clear legal necessity that some contracts or legal pronouncements be in writing, certain government agencies and other organisations may create procedures requiring written versions of these papers. Generally speaking, the situation in the Free Zones is similar to that onshore, and examples of legal agreements/contracts that need for formal form are marriage, real estate deals, and certain negotiable instruments. In the same spirit, certain government agencies and other organisations may create systems wherein they demand documents/contracts/legal pronouncements to be in writing even when there is no particular legal obligation for them to be in writing.

Federal Decree-Law No. 46/2021 on Electronic Transactions and Trust Services (the Electronic Transactions Law) provides that if there is a legal requirement to keep a document, record or information then this will be fulfilled if stored in electronic form, provided that certain conditions are met. These conditions include that the electronic record must be in its original form or in a form which accurately reflects the information as it was originally generated, sent or received; the information must be accessible; and any information which facilitates the determination of the origin, destination, time and date of the sending or receiving of electronic information should be retained (eg metadata). [lxxv]

Federal Law 18 of 1993[lxxvi] Issuing the Commercial Transactions Law (the "Commercial Transactions Law") provides that a trading company must keep the originals of all correspondence, telegrams and invoices sent or issued by it for the purpose of its business for a minimum period of five years from the date of issue or receipt (Article 30). It, therefore, follows that this requirement will be met if the foregoing is stored in electronic form, provided that the conditions of the Electronic Transactions Law are met.

On this issue, the status in the DIFC and ADGM is much the same as Onshore. A legal requirement to keep records or information will be satisfied by records or information stored in electronic form, subject again to similar conditions to those set out in the Federal Electronic Transactions Law being met, according to the respective Electronic Transactions legislation for each of those Free Zones, the DIFC Electronic Transactions Law No2/2017 and the ADGM Electronic Transactions Regulations 2021. [lxxvii]

1.1. RELEVANT COURT PRACTICES

The Electronic Transactions Law makes a distinction between “protected electronic signatures” and other electronic signatures. An e-signature will be considered protected if:

a) it is possible to verify the signature through the implementation of a precise authentication procedure in accordance with the Electronic Transactions Law; or
b) if it is commercially acceptable and agreed between the parties that at the time of its execution it is attributable only to the person using it; it is possible to prove that person’s identity; it is fully controlled by that person and it is connected to the relevant electronic message by a link that provides reliable proof of the validity of the signature.

Courts in the UAE shall evaluate the reasonableness of reliance on the electronic signature in line with the Electronic Transactions Law if the in issue electronic signature is not recognised as a protected e-signature (because it does not satisfy the aforementioned conditions). Whether it is common practise to rely on electronic signatures for the specific type of transaction under consideration, the value or importance of the transaction, and whether the party relying on the e-signature took the necessary steps to ensure its validity are among the factors used to determine reasonableness.[lxxviii]

Due to the fact that Onshore UAE is a civil law jurisdiction, court decisions rendered there are not legally binding. The difference between protected e-signatures and regular e-signatures is not made in the same way by the DIFC Electronic Transactions Law and the ADGM Electronic Transactions Regulations. Instead, the relevant laws provide standards that may be used to assess the legitimacy and dependability of an e-signature. The DIFC and ADGM uphold the standard established by past court rulings.[lxxix]

7.8. IN WHICH CASES ARE DOCUMENTS ONLY WITH WET INK SIGNATURES ACCEPTED?

The Electronic Transactions Law excludes the following types of transactions from its scope, thereby necessitating wet ink signatures:

- transactions and matters concerning civil status (eg marriage, divorce and wills);
- title deeds of real estate;
- bonds in circulation/negotiable instruments;

- transactions concerning the sale and purchase of real estate, its disposition and rental for periods in excess of ten years and the registration of any other rights related to it; and
- any document required by law to be executed before a Notary Public.

There are also separate specific rules regarding when government entities can use, or rely upon e-signatures and when wet signatures are required.

Both the DIFC Electronic Transactions Law and ADGM Electronic Transactions Regulations exclude the following types of transactions from their respective scope, thereby necessitating wet ink signatures:

- the creation, performance or enforcement of a power of attorney;
- the creation and execution of wills, codicils or testamentary trusts; and
- transactions involving the sale, purchase, lease (for a term of more than 10 years) and other disposition of immovable property and the registration of other rights relating to immovable property.

Furthermore, the DIFC Electronic Transactions Law confirms that wet ink signatures will be required for the creation, performance, or enforcement of a declaration of trust (except for implied, constructive, and resulting trusts) and for the creation, execution, and use of affidavits or affirmations as evidence in court proceedings. Moreover, the ADGM Electronic Transactions Regulations provide that a wet ink signature is required for every document that must be notarized in front of a notary public. Smart contracts executing transactions that necessitate execution through notarization must be executed off-chain. Agreements between parties relating to certain civil matters, title deeds of real estate, bonds etc must be executed off-chain for such agreements to be enforceable.

8. ADVANCEMENT IN THE DECENTRALIZED ONLINE DISPUTE RESOLUTION SPACE

Currently, a handful of successful online dispute protocols offer products that supposedly perfect the smart-contracting process. These applications are similar in many key respects, but each one attempts to differentiate itself from its peers by trumpeting unique juror-incentivization strategies, different levels of legal enforceability, and specialized tribunals.

The online dispute platforms are as follows: - [lxxx]

1. Kleros
2. JUR
3. Aragon Network Jurisdiction
4. OpenCourt
5. OpenBazaar

8.1. AGREEMENT FORMATION

An escrow-like system may be implemented to simplify agreement generation in on-chain applications.[lxxxi] A purchaser deposits sufficient monies into a smart contract at the outset of a transaction. Until either (1) the buyer verifies satisfaction with the seller's performance or (2) any initiated dispute is resolved, this bitcoin payment will be kept in escrow on the blockchain. It's important to note that purchaser manifestation of approval can only occur if the smart contract has already specified a dispute resolution application, such JUR or Kleros. The buyer can halt the smart contract one step before completion and request that the programme settle a disagreement thanks to this code-based identification. Various procedural aspects of the disagreement must also be predetermined, depending

on the platform. Kleros, for instance, requests that users select the number of jurors, a particular "sub court," and a list of prospective witnesses.[lxxxii]

The majority of these dispute resolution tools also provide consumers the option to design a natural language contract to go along with the code-based smart contract. The level of contractual clarity and comprehensiveness varies by platform, with certain applications going to great lengths to achieve traditional legal enforceability. For instance, OpenCourt provides templates for creating a contract in plain language to go along with the Solidity code-based contract. The application interface enables Ethereum users to fill out templates with generic arbitration terms, anonymous Ethereum addresses, and ether values. The parties are able to "produce a legally valid bill of sale that is controlled and digitally signed through a blockchain" as a result of this. It's important to note that any "bill of sale" is completely separate from the smart contract.[lxxxiii] The existence of a phrase in natural language does not guarantee that the code will really perform that function. In fact, when party intentions and code manifestations conflict, numerous smart contract conflicts result. When parties want to participate in on-chain resolution, these two elements—a pre-coded smart contract and its plain language counterpart—are the means by which they enter into and begin an agreement.[lxxxiv]

8.2. Dispute Resolution Initiation

The applications for starting a dispute differ little since each accessible platform has an escrow-like structure. In all circumstances, the dissatisfied purchaser may use the programme to start a dispute before the coding is finished.[lxxxv] Due to the fact that they have not deposited a payment to the smart contract, sellers typically lack this power.[lxxxvi] The soundness of a seller's stance on her justification for not performing will ostensibly be determined by the adjudication procedure.[lxxxvii]

However, there are minor variances between platforms in terms of the responsibility given to the consumer who initiates the dispute. On JUR, for example, the party that initiates the disagreement must provide a specific remedy at the outset. After that, the defending party has twenty-four hours to come up with a counter-solution. Unlike Kleros' pre-coded relief possibilities, this is designed to provide flexibility for closely tailored solutions.

8.3. Evidence and Arguments

Regardless of platform, detection methods and subsequent advocacy options are limited. In most cases, discovery is wholly voluntary and self-imposed. The discovery process, according to Kleros, JUR, and Aragon, consists simply of parties unilaterally uploading whatever evidence that they believe will best support their argument. Links to incomplete websites, photos with pertinent information, and on-chain party correspondence are all instances of this type of evidence. There is no method for jurors to force further discovery, and counterparties have only a limited ability to request further relevant papers from the opponent. A single, unvetted data dump is used in the discovery process.[lxxxviii]

Disputants, likewise, have a limited amount of time to clarify the substance of their complaints. While the style varies by platform, each application requires both parties to supply some type of "statement of facts." In what effectively amounts to a textbox, each party reasons why they believe they are entitled to relief. There is no ongoing dialogue between jurors and disputants across many venues. Parties are usually unable to defend counterclaims and provide clarifications regarding their own past comments when a juror becomes bewildered. There is only one textbox in this section.[lxxxix]

On-chain platforms provide no basis for establishing an argument, limiting advocates' persuasive opportunities. Platforms, at best, provide vague instructions for jurors to follow when making a decision. These rules, on the other hand, do not address the entire spectrum of potential conflicts, frequently urging jurors to make a judgement based on what they believe to be "fair.".[xc]

8.4. Juror Selection

Juror selection relies on the essential functionality of blockchain disaggregation, adopting incentive-based crowdsourcing analogous to miner consensus validation, among those platforms that aspire for pure decentralisation and anonymity. On-chain anonymous juror applicants willingly volunteer, unlike involuntary jury selection in the United States. In the hopes of being chosen as a juror, a candidate puts a bitcoin deposit in the amount of her choice.[xci]

The juror-candidate may be able to post this deposit to a specific sub-court, depending on the platform. JUR, for example, offers virtual tribunals called "Hubs," in which application administrators evaluate jurors for specific criteria. Similarly, Aragon charges extra fees to litigants who want a pool of jurors with good "reputations." "[W]hen a user causes a disagreement, they must pay an arbitration charge equivalent to the amount of reputation that will be included on the jury," according to Aragon's White Paper. This is designed to encourage proper decision-making and screen out unjustified claims.[xcii]

Once a sizable adequate number of applicants have made token deposits, a random lottery is held to choose the jury. On certain sites, the amount of a deposit directly affects the likelihood of being chosen in this lottery. The combination of proportionality and randomness is cited by application developers as a technique for discouraging hostile actors from trying to generate a large number of Ethereum addresses and take over the entire voting system.[*xciii*]

8.5. Juror Decision-making and Financial Incentivization

The process used by OpenCourt is a notable exception to this volunteer lottery. Instead, OpenCourt requires each disputant to enter a pseudonymous Ethereum address of a third-party arbitrator who has been mutually agreed upon. When used on-chain, this mutual appointment mirrors the selection processes used by on-chain arbitration tribunals, but it comes with its own set of criticisms. E. Financial Incentives and Juror Decision-Making Fully decentralised, on-chain juror systems have two crucial characteristics that set them apart from every other adjudicatory procedure in the world. First, as previously said, jurors remain completely anonymous throughout the arbitration process. Second, on-chain applications use a majority-voting system that is monetarily rewarded. Jurors who do not vote in accordance with the majority will forfeit some or all of their initial deposit.[xciv]

8.6. On-Chain Appeals Process

Most fully decentralised platforms allow a disgruntled party to appeal after the original judgement, with the format and cost varying by platform. For example, each subsequent appeal on Kleros doubles the number of jurors and hence the up-front arbitration fee. The purpose of this cost-doubling mechanism is to deter excessive appeal proceedings. Similarly, but differently, Aragon disputants have the option of appealing an initial ve-juror panel's ruling. Appellate proceedings necessitate a doubling of the jury's reputational weight, and consequently a doubling of the appellant's arbitration fee. All jurors on the Aragon Network are encouraged to post a bond and rule on the merits of the disagreement in this subsequent phase of the review, called a "Prediction Market.[xcv]

This expensive mass review is meant to discourage parties from filing pointless appeals while also increasing decisional accuracy through a larger sample size. A party may ultimately file an appeal with Aragon's "Supreme Court" if they are still dissatisfied with the outcome of a prediction market decision. Nine anonymous jurors with the highest reputational standing on the platform make up this court. The decision made by these nine arbitrators will settle the conflict and put an end to it. It's interesting to note that, in accordance with Supreme Court decisions, the monetary rewards provided to jurors in earlier rounds may be retrospectively revoked.[xcvi]

These two appeal processes serve as an example of potential on-chain solutions. They also signify the resolution of a conflict and the cessation of a user's right to redress. The smart contract unfreezes and distributes assets in accordance with the decision.[xcvii]

8.7. Type of Disputes

Apart from the actual adjudication methods, it's vital to notice the types of conflicts that on-chain apps try to resolve. To do so, it is important to visualise the universe of potential disputes as a two-by-two matrix, segregated by dispute origin and resolution forum. Intuitively, the dispute forum will be on-chain or off-chain. The dispute type, which includes an on-chain or off-chain option, is a little more complicated. On-chain disputes are ones that occur only in the context of blockchain transactions. Disputes arise solely as a result of smart contract malfunction due to bugs in the code and phantom transactions. A dispute with an on-chain origin, on the other hand, is exemplified by a freelance designer who fails to produce a customer's website on time.[xcviii]

The dispute arises solely due to human error in trying to accomplish the contract. The cause of the complaint is unrelated to blockchain specifically. Although both sorts of difficulties may be resolved on-chain, existing systems are touted as solutions for dealing with the latter: smart contract human error.

In fact, on-chain dispute resolution platforms would have very few real-world applications if they were limited to exclusively code-based conflicts. These new apps' purportedly disruptive addition is their ability to lessen the damage caused by unscrupulous actors that operate on the supply chain (i.e., malfeasance or nonfeasance). There is no longer a concern that consumers would be helpless in the event that an oracle-driven blockchain transaction goes wrong with the introduction of the on-chain resolution. Businesses need a way to control the individuals involved in the transaction and so limit their liability if they are to ever trade on-chain and at scale. The likes of Kleros, JUR, and others assert to be that mechanism. They also assert that they can fill this gap without compromising the main advantages of blockchain technology. Further, they claim to fill this void without sacrificing the core benefits of blockchain technology. However, appealing this sales pitch may be, it is far from the truth.

8.8. Other solutions in the Online Dispute Resolution Space

8.8.1. Mattereum

A legal-tech firm comprised of lawyers, cryptographers and software engineers—presents itself as providing “the legal, technical and commercial infrastructure layer for the on-chain property transfer and control.” On-chain transactions are those that take place and value is exchanged on the blockchain network. Mattereum supports a decentralized commercial law system, the Smart Property Register, that executes through automated smart contracts that ensure property rights, as well as dispute resolution and enforcement. This register facilitates the “on-chain property transfer” through a smart contract that in effect becomes a “legal contract” without the need for legislative support.

The contract protocol is based on the notion of "Ricardian Contracts," defined as "smart APIs for the legally-enforceable transfer of property rights" that "serve as the glue between the complex and bureaucratic legal world and the fast-moving digital world of data." The focus is on dispute avoidance by setting a system whereby an "automated custodian" becomes the legal owner and registrar of an asset for the duration of the contract which makes enforcement easier. Nevertheless, Mattereum also acknowledges that issues with enforcement will remain and therefore propose that "technically competent mediators" will resolve any remaining disputes. In another post in 2017, Mattereum's CEO Vinay Gupta announced the establishment of a "decentralized commercial arbitration court" that "is recognized as an arbitration court under the 1958 New York Convention and can therefore make legally binding awards that will be enforced by national courts in nearly all of the countries in the world."[xcix]

8.8.2. LTO Network

LTO Network is a 2014 start-up from the Netherlands. The LTO platform establishes a Ricardian "living contract on a private blockchain." A live contract is comparable to the Ethereum platform's smart contract in that the code is based on automated logic and can be executed in a "trustless and verifiable" manner. Smart contracts contain the exchange of value that is "unlocked" when conditions are met, whereas live contracts do not hold money but specify how two or more parties may "interact." A non-disclosure agreement, for example, is handled differently under a live contract because it would be impossible to keep the entire penalty for breach as a deposit.[c]

8.8.3. Sagewise

Sagewise is a 2017-founded dispute resolution service. Sagewise's pitch is that the lack of an amendment facility might damage smart contracts, creating hypothetical circumstances where fundamental code flaws could lead to disagreements. Sagewise makes use of a smart contract's SDK (Software Development Kit) protocol. The Sagewise SDK includes an amendment programme to address concerns like the varying quality of smart contract code; (ii) contract stakeholders' lack of technical understanding; (iii) grey areas and unforeseen complications; and (iv) the possibility of conflict and the need for arbitration.[ci]

8.8.4. Monetha

Monetha is an electronic commerce network that uses blockchain technology to enable decentralised, peer-to-peer transactions between merchants and customers. It was founded in 2017. The platform includes a "decentralised reputation architecture" that enables "participants to evaluate one another's trustworthiness by securely accessing context-relevant information." A dispute resolution procedure is included in the platform's payment system ("payment layer"), where a participant can submit a claim on the blockchain, which will subsequently be handled automatically by a smart contract. The method includes a step in which the parties are given 72 hours to "off-chain" resolve the claim. If the claim is not satisfactorily resolved, any of the parties can file a new claim to restart the process using a smart contract.[cii]

8.8.5. Enigma

Enigma is a "decentralised computation platform" predicated on the notion of anonymity by design, which began as a research project at MIT in 2015. The Enigma platform includes a protocol that allows users to build "secret contracts," or privacy-preserving smart contracts, on a distributed network. "The main difference is that the data itself (inputs and outputs to the contract) is disguised from the nodes that

conduct the computations," as Enigma creators put it. App developers can now integrate sensitive data in smart contracts without having to move off-chain to centralised (and less secure) platforms.

8.8.6. Data Protection under Smart Contracts

In a range of business and government situations, smart contracts offer the potential to simplify and speed processes. If personal data is processed, it may be subject to the terms of applicable data protection legislation, such as the General Data Protection Regulation of the European Union (GDPR). The GDPR is the focus of our investigation since it is now the most relevant and influential data protection legislation, thanks to its comprehensive nature and extraterritoriality and its application to smart contracts.[ciii]

By their very nature, smart contracts make it impossible to categorise the numerous parties involved, which will have an impact on their legal responsibilities and potential responsibility for violations.[civ]

Furthermore, many rights afforded to data subjects under the GDPR and regional data protection laws applicable in Arab countries, such as the right to be forgotten/right to erasure, the right to rectification, and the right not to be subject to a decision based solely on automated processing, may be challenging to satisfy in the context of smart contracts. Along the way, the important distinction between anonymized and personal data and its practical ramifications is discussed, and data integrity and confidentiality (security) criteria are detailed.[cv]

In addition, when the GDPR and regional data protection laws applicable in Arab countries are in effect, the principle of privacy by design and default must be followed. When creating smart contracts, data security and privacy must be considered. Privacy by design must be considered a best practice even for states outside of the European Union, with policymakers and industry players responsible for creating the architecture for smart contracts giving fair consideration.

Within the Arab region, several countries have implemented holistic personal data protection regulatory regimes and other sector-specific federal laws, which will interplay with smart contracts. Examples include:

(a) Data Protection: United Arab Emirates

The UAE's federal data protection law, which took effect on 2 January 2022, clarifies acquiring, processing, evaluating, and transferring personal data. This law strengthens the rights of data subjects and the obligations of persons collecting, processing, analysing, and transferring personal data. Under the new federal personal data protection law, workers or data subjects have more control over their personal data. Personal data may be transferred to another controller, rectified if incorrect, or deleted if no longer required. Employees may delete data that is no longer required, have lost authorization, or violate data protection rules.[cvi]

Whilst smart contracts have the potential to improve the efficiency and speed of many commercial and governmental interactions in the UAE, data protection regulations may impose certain restrictions on smart contracts, should personal information of natural legal persons be handled. As a result of the data protection law’s extra-territorial breadth, omnibus character and the very nature of the law, smart contracts create problems for categorizing the many parties involved, influencing their legal obligations and possible liabilities for violating the contract. This highlights an important aspect that policymakers and industry players need to account for, i.e., examining data controller duties in smart contracts. It would be prudent for such stakeholders to provide supervisory recommendations for both the data

controller and data subjects' rights and obligations to help the implementation of smart contracts achieve compliance and consonance with the prevailing federal data protection laws.

Several of the rights guaranteed to data subjects, such as the right to deletion, right to correction, and right not to be subject to a fully automated decision, may be challenging to satisfy in the context of smart contracts in the UAE. In order to achieve a result as close to erasure as feasible, the use of encryption to make data almost inaccessible may be explored to provide protection to data subjects in the state.

(b) Data Protection: The Kingdom of Bahrain

The Personal Data Protection Law No. (30) of 2018, which came into force on 1 August 2019, governs personal data in Bahrain. The legislation explicitly excludes the processing of data by any individual for personal or family reasons and the processing of data by Bahrain's security agencies for national security objectives.

The law defines the forms of processing that fall within the ambit of its application as the processing of data by non-automatic means that form or is intended to form part of a file system. Smart contract design and development must comply with the law in Bahrain. The developers and policymakers must ensure that smart contracts do not contain information that is against the data processing rules or against the national interest of the Kingdom of Bahrain.

(c) Data Protection: The Kingdom of Saudi Arabia

The Draft Executive Regulation for the Data Protection Law ("the Draft Executive Regulations"), dated 9 March 2022, was issued by the Saudi Authority for Data and Artificial Intelligence ("SDAIA") in collaboration with the National Data Management Office ("NDMO") on 10 March 2022, along with a public consultation on the same. In specifically, the Personal Data Protection Law ("PDPL") will be enacted by Royal Decree M/19 of 17 September 2021, approving Resolution No.98 of 14 September 2021. The Draft Executive Regulations seek to clarify the processes and execution of the requirements of the PDPL. Here, we have not attempted to offer a comprehensive examination of all the lexicon established by law. Some of them need to be looked at more closely, even if, on the surface, they do not seem to differ much from similar phrases used in other data protection laws.

Except for personal or domestic data processing, the law applies to all personal data processing carried out in Saudi Arabia and extends to personal data processing outside Saudi Arabia concerning data subjects in Saudi Arabia. An exception to this rule is where personal processing data on a dead person's remains might lead to their identity or that of their family members.

The law bans the use of personal data without authorization, except in certain instances. Consent is also necessary if the data controller desires to use the personal data for purposes other than those for which the data subject himself first collected it. Due to this, there may be certain cases where the smart contract may require consent for data processing. Additional information on permission includes information on the instances in which consent must be acquired in writing and the data subject's ability to withdraw consent at any time (such as minors). The provision of a service or benefit unrelated to the service or benefit for which permission is sought/acquired does not need consent.[cvii]

Many business and government relationships might benefit from the use of smart contracts in Saudi Arabia. Once again, we note that privacy as a design must be an integral part of smart contract development as the law bans the use of personal data without authorization except in certain instances. A smart contract might make it difficult for Saudi-domiciled entities to fulfil certain rights provided to data subjects in various scenarios. The smart contract architecture must have conditions and compliance

abilities present, allowing data removal to comply with data protection laws. This shall require coordination between all the stakeholders to ensure that the smart contract framework complies with extant regulations.

8.8.7. BLOCKCHAIN, SMART CONTRACTS AND CONSUMER PROTECTION

For compliance professionals, both blockchain and smart contracts will provide substantial problems and change. Compliance methods and associated testing regimens will have to evolve when blockchain replaces conventional bank ledger and physical negotiable instrument operations with more automated processes. Eliminating current market mechanisms may result in the abolition of a transactional layer that is now vital to providing consumer rights. Compliance testing will necessitate much more computer science and information system understanding in a blockchain-dominated financial system.

Compliance professionals will ensure the blockchain process's security through cryptography, distributed processing, and consensus protocols, among other methods. Blockchain will not be practicable without suitable precautions such as those listed above. However, it appears that acceptable safeguards can be constructed in these early days.[cviii]

The first reaction to smart contracts, which were originally defined as "a series of promises, expressed in digital form, including protocols within which the parties carry on these promises," was that they lacked the basic legal requirements of a contract. Concerns have also been raised about consumer transactions, with the possibility that consumer knowledge and disclosures to customers will be more difficult to attain or provide in a blockchain system.

It may be reassuring to know that smart contracts, in their current form, fall in between contracts written wholly in code and contracts written entirely in normal language with merely an encoded payment mechanism. Smart contracts could be entirely written in code with a natural language counterpart, or they could be entirely written in natural language but executed entirely in code. There are other possibilities, but the pressure will be on contracts written fully in code from an efficiency aspect.[cix]

Compliance experts and consumer protection regulators will be concerned about assuring customer awareness of transactions when using blockchain technology. As a result, the focus from a compliance standpoint may be on plain language contracts, in contrast to the technological strain of blockchain on contracts written in code.

How can regulators and compliance professionals verify that consumers have adequately weighed the matter and been fully informed before acting when they can engage in substantial contracts with the click of a mouse - such as buying a house or obtaining a mortgage? At first glance, consumer education and disclosures appear to be in jeopardy.

Consumers can be confirmed to have received critical disclosures via electronic communication, possibly even via the blockchain itself. This confirmation could be more reliable than traditional non-digital methods. Who knows if a customer opened such a letter? However, the blockchain might make contract fulfilment contingent on electronic certification of receipt of disclosures or other data.
Similarly, digital technology may ensure that customers have evaluated the key terms and aspects of natural language contracts. As regulators and compliance professionals know, consumers do not always focus on or understand the details of a residential real estate secured loan. In a more digitised transaction, however, the blockchain method may be able to validate that consumers have gotten information, even demanding customer verification that they have reviewed specific provisions. While inefficient, such a

procedure could be less burdensome and more effective in terms of consumer education than the current physical signing of disclosure paperwork.[cx]

With modern technologies, more proof of customer reception and consideration of information may be achieved. For example, it may be feasible to determine how long a customer looked at the material. Before a genuine one-click mortgage or home purchase can meet consumer protection concerns, some adjustment to the "click-through" agreements currently in use on the internet – which virtually no consumers read thoroughly – is clearly required.[cxi]

The human-machine interface complicates consumer protection compliance in blockchain transactions. However, it will not simply affect consumer protection. How will blockchain institutions, for example, identify their customers for anti-money laundering purposes? Compliance professionals, particularly those in the financial services industry, would be well to start learning about this new technology. Blockchain and smart contracts will be here sooner than one might expect, thanks to the rapid speed of technological advancement.[cxii]

8.8.8. Legal Tech Projects dealing with the Enforceability of Legal Contracts with Smart Contract Computer Code

8.8.9. The Accord Project

A worldwide non-profit group called The Accord Project is attempting to improve knowledge about and use of smart legal contracts. For smart legal contracts, The Accord Project is creating an ecosystem and open-source tools. Currently, the Linux Foundation is in charge of it. The Accord Project has members from many different disciplines and countries.[cxiii]

The focus is on open-source programming, which means that anybody can utilize and contribute to development, is a significant component of the community. The Accord Project's working groups cover transactions, supply chain, financial services, intellectual property, venture and token sales, real estate and construction, and dispute resolution.[cxiv]

The Accord Project's major purpose is to create and maintain a uniform legal and technical foundation for smart legal contracts, with the hope that this consistency will lead to familiarity, comfort, and ultimately trust among users, including individuals, businesses, lawyers, and financial advisors. According to the Accord Project:

"With an increased focus on enterprise digitalization, adoption of blockchain technologies, and the growth of the API economy, the usage of computable agreements is rapidly increasing. Having a common format for "computable" legal agreements is an important cornerstone for the future of commercial relationships. One of the main purposes of Accord Project is to provide a vendor-neutral ".doc" format for smart legal agreements."[cxv]

8.8.10. Standards Australia

Standards can also be used in conjunction with smart legal contracts to help promote the adoption of innovative technology.

Standards Australia has taken the lead in developing a smart contract standard in the context of blockchain. Standards Australia was also involved in and contributed to the recent Technical Report on

Smart Contracts published by the International Organization for Standardization (ISO). The study looks at the advantages of smart contracts, their functions, and how they interact with one another on blockchains and other distributed ledgers.[cxvi]

Philippa Ryan, Chair of the ISO Australian mirror committee for Smart Contracts and Board Member of Lander & Rogers, spoke about the role that government and industry-backed standards can play in supporting smart contract adoption and developing trust in them:

"Standards and other publications…can improve the reputation of innovative technologies and lead the way in describing best practices. Developing and setting standards requires consensus, which encourages an international community of experts to share, collaborate and agree. This report is an example of successful international cooperation, with Australia leading the cause."

Establishing an effective governance structure through the further development of international standards, particularly those endorsed by an organization like the ISO, has considerable potential to increase public and commercial sector understanding, confidence in, and legitimacy of smart contracts. This is especially true given the cross-border character of smart legal contracts, which makes regulating them challenging for sovereign legislators.

8.8.11. THE FUTURE OF LEGAL DOCUMENTS WITH SMART DOCUMENTS POWERED BY BLOCKCHAIN TECHNOLOGY WITH DOCUMENT AUTOMATION

Thomson Reuters' Contract Express is the most efficient way to produce the most up-to-date, consistent, and correct legal papers. OpenLaw created the world's first decentralized peer-to-peer legal agreement system. When you combine the two, you may develop legal papers with far more powerful and distinctive features, as well as greater efficiency and security.

The first proof of concept demonstrates how Contract Express may be used to construct a contract from a Practical Law standard document and convert specific clauses into smart contracts that can be executed on the Ethereum blockchain using the OpenLaw protocol. Smart contracts' efficiency and security would enable real-time payments and quick settlements of financial transactions, for example, facilitating the transformation of financial and commercial enterprises.[cxvii]

"This proof of concept demonstrates how users could incorporate blockchain-enabled smart contract provisions into any legal template they create within Contract Express, including the many automated standard documents available from Practical Law," said Andy Wishart, Global Head of Drafting Tools & Productivity Solutions at Thomson Reuters. "And the process is seamless and intuitive to the extent that lawyers will not need specialized technical or blockchain expertise to create smart contracts. This represents a jumping-off point for further efforts to make blockchain technology and smart contracts more accessible to the mainstream legal industry."

"By bringing OpenLaw and Contract Express together in this way, we have demonstrated that smart contract technology can be integrated into the automation tools that lawyers are using today," said Aaron Wright, co-founder of OpenLaw. *"This opens up the possibility for lawyers to capitalize on the future benefits of blockchain-enabled legal services, and this proof of concept represents a first step in exploring how blockchain-based smart contracts can be applied to a full commercial transaction."*

8.8.12. About OpenLaw

Through technical infrastructure APIs and a range of tools, OpenLaw supports the OpenLaw protocol and assists organizations, customers, and developers in incorporating this powerful technology into their commercial dealings and initiatives. Any company, from a startup to a major public corporation, can use these tools to produce and transfer tokens efficiently and safely using a legal agreement signed and executed on a blockchain.[cxviii]

8.8.13. Example Call on OpenLaw for a smart contract

All OpenLaw agreements can be easily digitally signed. Once an agreement has been finished, it can be delivered by email for signing. Signing is as simple as clicking a button, and signatures are saved on the Ethereum blockchain, giving them some persistence for future reference. Once all necessary parties have signed, each party and the sender receive an executed copy for their records. Legal agreements made using OpenLaw are more private and secure since they are kept on IPFS and the Ethereum blockchain.[cxix]

The information is less vulnerable to cyber security concerns because none of the legal templates or created agreements are stored on our centralized servers or the centralized servers of Amazon, IBM, or Google. Lawyers will soon be able to create and handle papers in a fashion that closely matches the paper-based world, without having to go through third parties who aren't privy to the contract.

8.8.14. Smart Contracts and Challenges in Relation to their Legal Enforceability and Validity

8.8.14.1. Challenges Related to Legal Enforceability of Smart Contract

8.8.14.1.1. Challenges related to private law and smart contracts

There are a host of legal issues to consider in the private-law domain when using smart contracts on a blockchain. The issue of liability needs to be addressed if the contract has been miscoded such that it doesn’t achieve the intent of the parties, or the oracle makes a mistake or deliberate error. In addition, the parties will need to agree on applicable law, jurisdiction, general principles of proper governance, dispute resolution, privacy and the means of digital identity. Is the contract available in writing as well as code so that the parties know what they agree to? Can the identity of the parties be established with sufficient certainty to render the contract valid? If these challenges are not addressed in advance, despite the parties acting in good faith, they may find that they do not actually have a contract, and if problems arise, they have no agreed-upon means of resolving them.[cxx]

8.8.14.1.2. Challenges related to public law and smart contracts

From a public-law perspective, there are obviously risks that permissionless blockchains are used for illegal purposes such as money laundering or to take advantage of pseudonymous involvement to get around competition-law issues. Participants may be exposed to the “miners” who create new blocks acting irresponsibly or not acting in good faith. Currently, there are no specific legal remedies against corrupt miners.[cxxi]

8.8.14.2. THE GAP BETWEEN A CONTRACT AND A CODE

Because computer code and legal writing are inherently unrelated to one another, the question of whether a smart contract is even an enforceable contract arises. They use specialised languages with rules for how those languages should be created and interpreted; they have formal structures with a multitude of functional components that interact with one another in accordance with a well-defined logic; and they even share the concept of "execution." These similarities may lead us to believe that they are not all that dissimilar from one another. But when you look closer, it becomes clear that these are two entirely different kinds of things: on the one hand, a contract between human agents, embodied in human language, which people carry out based on their interpretation of those words in human language; and on the other hand, code that is ultimately compiled and executed by computer processors as strings of binary machine code at a high level of abstraction and yielding real-world outputs only to the extent that they are executable in real-world environments. Although it can "run" software code, the execution of machine code on a computing platform has little to do with the execution or performance of a contract. If smart contracts as code are to be executable in the same sense as legal contracts, how can the gap between those two domains be bridged?[cxxii]

8.8.14.3. NO HUMAN INTERVENTION IN SMART CONTRACTS

The implementation of a conventional contract depends on the parties' individual actions because it is only an inactive document (or even an oral communication). A smart contract can be partially or fully carried out by computers without the direct involvement of the parties.[cxxiii]

A smart contract may be enforceable in the alternative meaning of being influenced by an autonomous technical process that, once started, cannot be interrupted, rather than necessarily having its output (i.e., performance) enforced by a court. It should not be necessary for the seller to intervene to guarantee that the transaction (the delivery of a can of soda) is carried out if I insert a coin and make a legitimate selection; rather, it should be autonomous and the vendor should have no more power to interfere with its completion. [cxxiv]

Thus, if a party wants to alter anything in the contract, it is not possible for them to do so as there is a restriction on human intervention.

8.8.15. AI: NOT THAT SMART YET FROM LEGAL PERSPECTIVE

An alluring short cut to smart contracts could be to rely on the rapidly developing field of artificial intelligence (AI), which relies on the fact that computers will soon be able to process human language on par with humans, allowing them to understand the terms of a contract and act as the parties' robotic agents to carry them out.

None of the smart contract technology competitors now operate at that level, though; instead, they all aim to transform the contractual obligations that can actually be carried out into something with the conceptual rigour and formal clarity of existing computer code, which would not permit the ambiguity inherent in human language. To put it another way, smart contracts are smart as in “smartwatch” (i.e. connected), not as in “intelligent” .[cxxv]

8.8.16. SMART CONTRACT REQUIRES CREATING A FORMAL LANGUAGE THAT WORKS BOTH ON THE HUMAN LANGUAGE LEVEL AND ON THE MACHINE LEVEL

There are relatively simple contexts where the idea of a dual function, formalized language is really not too difficult to imagine. Take the following instruction: *"If today's date is 1 January 2018, pay £1.00 out of Party A's account to Party B's account."* Although its meaning in English is straightforward, it doesn't appear to be a proposition that would be difficult for a software agent that can also initiate payments to interpret and carry out with a little formalization. It should be simpler to develop modular "blocks" of contract code the more fixed the parameters and the more constrained the changes between individual contracts are, where standardized paragraphs in this formalized language implement the necessary function, both as machine-readable code and as English text. Then, using these building blocks, a complete smart contract may be constructed, much like Lego bricks. .[cxxvi]

8.9. DISPUTE RESOLUTION

Dispute resolution is a notion that traditionally has been handled by lawyers and courts, so it's easy to assume that technology advances can't provide a viable alternative. However, let's assume that it's possible to include data from outside parties in a smart contract's code. In such instance, it may not be too difficult to write code so that the parties can invoke a specific section of the smart contract that asks for a third party's opinion (chosen, perhaps, from a pool of specialised smart contract dispute resolution experts). Depending on the nature of the disagreement, the third party may choose to intervene by suspending, terminating, or otherwise modifying the terms and execution of the smart contract. This would necessitate making allowances to the purely tamper-proof execution model to enable smart contract's "arbitrator" involvement, but this could be a fair trade-off if it ensures the parties that they will have recourse in the event of problems with the smart contract's performance.[cxxvii]

8.10. USE OF COMPLEX LEGAL CONCEPTS

There is no way to definitively determine the meaning of a widely-used legal concept outside of resolving individual cases. A party's promise to make "reasonable efforts" to reach a goal is one such example. As a matter of drafting, such language is selected instead of a strict duty to emphasise that there are occasions in which performance by that party is not required because it would go beyond a certain level of "reasonableness" in that context. The parties are free to agree on what will and will not be considered reasonable, but using the phrase "reasonable efforts" instead allows the question of what constitutes "reasonable" to be decided at the time an actual dispute occurs, depending on the specific circumstances of that case. We do not foresee any possibility of implementing these until much more powerful AI becomes available than is currently available, which can make that context-specific determination of reasonableness, as this type of concept cannot be set out in a formalised language that can provide a well-defined set of instructions for code to execute.[cxxviii]

8.11. HOW SMART CONTRACTS CAN BE IMPLEMENTED BY GOVERNMENTS

Public administration is one of the most relevant economic sectors because it is responsible for ensuring the economic growth of a nation and for establishing public policies that favour the social and economic well-being of citizens.

The existing public administration, however, is seen of as being sluggish and bureaucratic and does not effectively address the needs of society.[cxxix] Therefore, new viewpoints must be incorporated in order to

restore trust with models that are more transparent, quicker, more efficient, and integrated into citizens' daily lives. In this regard, the blockchain system serves not only for private entities seeking benefits but also for public entities in the fields of government, education, health, and the energy networks[cxxx], transport systems and social services, among others.[cxxxi]

In recent years, concepts like open government, transparency, and electronic administration have been used to suggest that public administration was being modernised. Despite this, public administration has not yet been able to satisfactorily incorporate the tools that would allow for the most effective and efficient public activity. Therefore, an administration that embraces technology advancement and uses the blockchain to enable individuals, businesses, and civil society groups to access pertinent information, enhance public services, and actively participate in decision-making should be taken into consideration.

Electronic voting, which decentralises authority and distributes it among the participating nodes to obtain consensus on the data stored in the database by being based on centralised systems and managed by a single source, is one of the advantages of blockchain technology. In a different instance, a Declaration for the creation of a "European Blockchain Partnership" was signed in 2018 in order to handle the impending digital transformation process for both public personnel and citizens using the blockchain.[cxxxii]

The Blockchain has numerous potentials, not just from a corporate perspective. Below is a list of several initiatives that are currently being innovated in the public sector:

8.11.1. BIT NATION

BitNation is a project based on smart contracts and Ethereum technology and is defined as a “Decentralized Voluntary Nation without Borders” or digital nation. It is an open government, governance project that proposes solutions to have protected but demonstrable identity documentation, “public” coverage or insurance systems, management of “bitreputation” or reliability between commercial agents, and generation of procedures, such as birth certificates, among others[cxxxiii]

8.11.2. D-CENT PROJECT

In order to create publicly owned "Citizen Participation Technologies," the D-Cent project, which is sponsored by Europe, is now in the research stage. However, it seeks better agility and public or diverse innovation. This project combines several efforts from around Europe, including those from Finland, Iceland, and Spain (in the latter case, represented by projects promoted by the municipalities of Madrid and Barcelona). Blockchain is one of the technical foundations that aims to create solutions for the democratic administration of Big Data (data created by citizens and cities), to safeguard privacy and data protection with rules, or to govern digital public discussion and deliberation spaces. [cxxxiv]

8.11.3. DECODE PROJECT

It is an EU-funded project that explores how residents will be able to manage their data in the event of increasing openness, automation, and digitalization of data about cities and identities, as well as the potential economic impact on these cities.

Pilot initiatives were promoted in the cities of Barcelona and Amsterdam. More specifically, in Barcelona it will centre on collaborative economies and the Internet of Things, while in Amsterdam it will centre on management of Open Democracy and the Internet of Things.[cxxxv]

8.11.4. PROPERTY REGISTRATION

A smart contract is in charge of automatically verifying all of those circumstances, making payment for the property, and registering it on behalf of the new owner. Blockchain enables the "tokenization" of assets so that its transmission can be carried out with the confidence that the seller is who he says he is and can answer for the buyer, the payment is who he says he is, and is the owner of the property that is transmitted.

In this sense, countries like Germany, South Korea, Ghana, Kenya, Singapore, Sweden, the United Kingdom, Brazil, Japan, the American state of Illinois, the Indian state of Andhra Pradesh, the Croatian and Ukrainian republics, and others are working on or have already applied property registration through Blockchain in an effort to address issues like fraud, corruption, transparency, and the lack of or abundance of data on the ground.

8.11.5. BLOCKCHAIN IN THE TENDER AND AWARD PROCEDURE

However, several similar themes and actions have been discovered in the model for the presentation and assessment of proposals provided by Freya Sheer Hardwick, et al., which should be directed to respond to different models depending on the legislation of the nation where it is implemented.[cxxxvi]

8.11.6. BLOCKCHAIN ON THE CONFIDENTIALITY OF THE DOCUMENTS

When public sector organisations give information to bidders during the bidding process, blockchain technology can ensure its security and secrecy. In this situation, the evidence of the presence of consent for the bidders' access is tagged and recorded on the blockchain.

Before any person outside the contracting authority has access to material that has been designated as confidential, they must first get their approval. In reality, no one will be able to access sensitive information without first getting the owner's permission thanks to Blockchain cryptographic keys. According to the agreed-upon contract, each blockchain transaction may have an associated lock, and it may be waiting before becoming active.

A tender system like the one described should, in any event, adhere to a number of secrecy and security standards, which are listed by Freya Sheer Hardwick:

- Bidders are unable to change their offers after they have published them to the blockchain.
- Until the deadline has passed, the bidding organisation cannot read the offer.
- Offers from one organisation cannot be changed by another.
- The other bidders' names are hidden from view.
- The auctioning process is unaffected by miners on the blockchain network.

Therefore, the Blockchain protocol's decentralised, transparent, and secure features can satisfy the requirements of public bodies regarding the secret information they manage, resulting in a more trustworthy and transparent method for its handling.

8.11.7. BLOCKCHAIN IN THE PROCEDURE FOR OBTAINING GUARANTEES

The presentation and return of guarantees refer to an extra innovation of complexity that may also be streamlined and automated with the use of blockchain, albeit this does not apply to all public procurement procedures.[cxxxvii] For instance, the European Union focuses on the regulation of transparency and

cybernetics, but Latin America lacks such regulations and has just recently started to explore the problem in nations like Peru.

On the other hand, integrating blockchain technology into public sector administrative processes necessitates a thorough study that is preceded by a review of the processes that underpin them, a reflection on their need, and an assessment of the potential for its simplification.[cxxxviii]

Also, the infrastructure on which the blockchains will run must be considered; this issue cannot be solved without taking the various administrative tiers into account. It should be highlighted that this technology will have several advantages since, unlike other technical disciplines, there are no barriers to overcome and because its implementation does not call for significant facility expenditures but does require some staff.

8.11.8. BLOCKCHAIN AND CENTRAL BANK DIGITAL CURRENCY

With the maturity of permissioned consortium blockchain, central banks have been attempting the application of consortium blockchain in CBDC. The most widely used consortium blockchain in CBDC are Ethereum, Corda, Hyperledger Fabric and Quorum. The main application scenarios of these projects include inner-bank payments, cross-border payments and settlements.

- **Project Jasper/CAD-coin** - In 2016, the Bank of Canada launched Project Jasper as a blockchain-based wholesale CBDC. Project Jasper developed a proof of concept of a payment system for high amount inter-bank payments. In the first phase, Ethereum is used to make payments between participants. In the second phase, the Corda blockchain is tested. The two phases demonstrate that central banks can benefit from blockchain-based wholesale payment systems, increasing efficiency and reducing costs. In order to investigate further uses for blockchain, the Central Bank of Canada expanded Project Jasper in 2017 and created a blockchain-based CBDC prototype called CAD-coin. In addition to the Bank of Canada, other commercial banks joined together to create the test-run CAD-coin interbank payment system.

- **Project Ubin** - In order to investigate the application of blockchain for the clearing and settlement of payments and securities, The Monetary Authority of Singapore developed a blockchain-based CBDC, Project Ubin, in 2016. Blockchain can be used in CBDC, according to five phases of trials. Ethereum is utilised to carry out inter-bank transactions in phase one. In phase two, decentralised inter-bank payments are investigated using Corda, Hyperledger Fabric, and Quorum. In phase three, delivery versus payment is investigated using smart contracts. The fourth phase tests blockchain-based cross-border settlement payments. As a continuation of phase four, phase five investigates the creation of a multi-currency payments model while conducting cross-border payments using blockchain and CBDC.

- **Project Stella** - A blockchain-based initiative between the European Central Bank (ECB) and the Bank of Japan, Project Stella focuses on cross-border payments. Phases one and two study the processing of large-value payments with blockchain, phase three assesses the viability of using blockchain to facilitate cross-border payments, and phase 1 concludes.

- **Project Khokha** - As a proof-of-concept interbank payment and settlement system built on the Quorum blockchain, Project Khokha was introduced by the South African Reserve Bank in 2018. Project Khokha, which primarily focuses on inter-bank transfers and excludes currency issuance, demonstrates how blockchain may speed up transaction processing and reduce transaction costs.

- **E-Krona** - The E-krona was proposed by the Swedish central bank in 2018. Using the Corda blockchain, CBDC. A two-tier, private blockchain-based approach is E-krona. In the first layer, the central bank controls the private blockchain network tier and has the authority to accept and welcome new network members. Additionally, the central bank is in charge of printing and withdrawing e-kronor. Through the second tier, members of the e-krona network distribute e-kronor to end users, who may subsequently utilise it for a variety of things. E-kronor is domestically oriented, and retail payments, such as payments between persons, are the key application cases.

- **Project Inthanon** - The Bank of Thailand (BOT) introduced project Inthanon in 2018 with the goal of creating a blockchain proof-of-concept for domestic wholesale CBDC. Project Inthanon, which focuses on wholesale CBDC, utilises a private-permissioned Hyperledger Besu network. Through a wholesale CBDC, Project Inthanon enables commercial banks to carry out domestic financial transfers such as inter-bank settlements. Project Inthanon demonstrated how blockchain-based CBDC may lower operational and regulatory risks, increase operational scope, and enhance payment efficiency.

- **Project LionRock** - To investigate the advantages and drawbacks of blockchain-based CBDC, the Hong Kong Monetary Authority (HKMA) proposed Project LionRock in 2017. Project LionRock produces a proof-of-concept CBDC on the Corda blockchain and assesses the technological viability of CBDC issuance with blockchain. LionRock takes into account scenarios for both retail and wholesale.

- **Project LionRock** – Inthanon - The HKMA and the Bank of Thailand (BOT) proposed Project Inthanon-LionRock to test blockchain-based cross-border payments at the wholesale level in 2019 in order to better investigate additional possible CBDC scenarios, such as cross-border payments. A blockchain tunnel network is utilised in the Inthanon-LionRock project to connect the two blockchain-based CBDCs LionRock and Inthanon. Real-time cross-border transfers, which are much more efficient and affordable than conventional cross-border payments, are made possible by LionRock-Inthanon. Additionally, LionRock-Inthanon is the first project to connect two CBDCs based on blockchain.

- Australia - The Reserve Bank of Australia announced a study to investigate a wholesale CBDC based on Ethereum in January 2020. The goal of the CBDC study is to examine how CBDC may affect the effectiveness, risk-taking, and innovation of wholesale financial market transactions.

8.12. HYBRID SMART CONTRACT-BASED BLOCKCHAIN GOVERNANCE

Both permissioned and permissionless blockchain governance features can be included in a hybrid blockchain governance approach. In contrast to the permissioned blockchain governance system, which concentrates control with only one corporation, it has minimal transaction fees. It does not permit every user on the web to take part in the transaction process, in contrast to the permission less governance model. By permitting and restricting participants in accordance with their needs, businesses like IBM and Multichain have embraced this strategy, enabling them to serve a broader audience.[cxxxix]

Since all the above three governance types possess special features and provide unique solutions in particular situations, every business can choose a governance style that suits them best.[cxl]

9. Implementation of smart contracts by government and Organisations

9.1. Blockchain applications and initiatives in Arab countries[3]

9.1.1. Jordan

Whilst the Jordanian government has not stipulated an overarching strategy for adopting DLT, we can see developments and use cases using DLT in Jordan. Arab Jordan Investment Bank (AJIB) offers retail, corporate, and investment banking services in Jordan, Cyprus, and Qatar. Traditionally, sending money between subsidiaries has relied on a network of correspondent banking partnerships and third-party intermediaries, making transactions lengthy and costly for both AJIB and its clients. AJIB has implemented the Oracle Blockchain Platform in the Middle East's largest blockchain deployment to facilitate significant improvement in cross-border money transactions' speed, security, and reliability. [cxli]

Additionally, the World Food Programme (WFP) of the United Nations performed the first successful large-scale testing of the Ethereum blockchain in Jordan on May 31, 2017, to transfer humanitarian supplies to Syria.[cxlii]

9.1.2. UAE

In April of 2018, the UAE announced its Emirates Blockchain Strategy of 2021, which outlines its intention to capitalise on blockchain technology to convert half of all government transactions onto the blockchain. The pillars of the initiative include the improvement of government efficiency, advancing legislation, facilitating global entrepreneurship and saving resources through the implementation of blockchain technology to:

- Routinely handle AED 11 billion in transactions and documents;
- Reduce 398 million printed papers yearly;
- save on 77 million labour hours annually.[cxliii]

The UAE will employ blockchain for digital transactions, assigning each consumer a unique identification number which shall link to their information on the security chain. As the information and data stored on the blockchain are at reduced risk of being hacked or altered, the digital security of national papers and transactions are strengthened while also lowering operating costs and speeding up decision-making.

The AI and Blockchain Joint Working Group announced the commencement of two government initiatives at the second UAE Government Annual Meetings in November of 2018. The AI and Blockchain Group's efforts intend to standardise a definition of AI and blockchain at the federal level. It also aims to assist respective public and private entities (including but not limited to smart local organisations) to familiarise themselves with the principles and applications of Artificial Intelligence. In collaboration with the Ministry of Higher Education, the Joint Working Group launched the National Program for AI and Blockchain Capacity Building, which aims to provide educational university programs and scholarships in the fields of artificial intelligence and blockchain.

[3] Arab countries are listed in their alphabetical order of the League of Arab States.

In conjunction with the Dubai Future Foundation, the Dubai Blockchain Strategy was established in 2017 by the Smart Dubai Office to make Dubai the first city to be entirely powered by blockchain by 2020. Government efficiency, industry creation, and worldwide leadership are the three cornerstones of the plan.[cxliv]

The Smart Dubai Office announced the introduction of the Dubai Blockchain Platform, the first government-endorsed blockchain-as-a-service in the UAE, in October 2018. The enterprise-ready platform, delivered through an IBM Cloud environment and created locally in the UAE, acts as a stepping stone for organisations in the UAE and around the world to move their blockchain testing and development into full production. It digitizes and transmits all relevant government operations and citizen services.

With the introduction of blockchain within the financial industry in 2015 and the unveiling of the Dubai Blockchain Strategy, Emirates NBD investigated how it might use the technology to make a significant effect at scale. In 2016, it collaborated with ICICI Bank in India to test blockchain for cross-border transactions and trade finance paperwork.[cxlv]

Another example could be Etisalat Digital, which is Etisalat's business unit that enables businesses and governments to become smarter via cutting-edge technologies such as cloud, cyber security, and internet of things (IoT) omnichannel, artificial intelligence, and big data and analytics.

To promote cryptography and blockchain technology in Dubai, the DMCC Crypto Centre opened in May 2021 and has already housed more than 140 organisations active in the field. The Securities and Commodities Authority (SCA) and the Dubai Multi Commodities Centre (DMCC) have inked an agreement to allow crypto asset-related businesses to be licensed in Dubai, attracting entrepreneurs and businesses from all parts of the world.[cxlvi]

As part of the UAE's blockchain strategy, Dubai Airport Free Zone Authority (DAFZA) struck a deal with SCA to help drive cryptocurrency development and expand the usage of blockchain in Dubai and the UAE.[cxlvii]

The Abu Dhabi Digital Development Authority has also been working on a government blockchain platform to allow and facilitate a safe, trustworthy data exchange mechanism between Abu Dhabi government bodies and any other external organisations. Blockchain technology would allow the government to create a "data marketplace," allowing for a value-driven data-exchange scheme.[cxlviii]

The strategies and initiatives adopted in the UAE have helped promote developing and creating a talent pool educated in DLT and smart contracts. The initiatives have led to the adoption of DLT by authorities, private players, and the public sector to increase efficiency and remove bottlenecks, leading to a more robust and inclusive technological hub for innovation. UAE is the prime destination for international companies, entrepreneurs and blockchain enthusiasts interested in doing business in the middle east concerning DLT, smart contracts and virtual assets.

9.1.3. BAHRAIN

Bahrain's Economic Development Board embraced blockchain in October 2017, certifying over 28 blockchain firms. At the same time, Bahrain's fintech capital flows from other Arab nations and China, India, and the United Kingdom have continued to grow.

As part of Bahrain's goal to become a leading FinTech hub in the Middle East, the Central Bank of Bahrain (CBB) implemented a legal framework for 'Regulated crypto-asset services' in 2019, which has been added to CBB Rulebook Volume 6, governing the country's financial markets.

Regulations for crypto-asset services are addressed in detail in the CBB's Crypto-asset rules, including everything from licensing and governance to minimum capital requirements and the control environment. A platform operator's monitoring and enforcement requirements include those given by platform operators in the Kingdom of Bahrain as a principal (agent), portfolio manager (advisor), and custodian.

For Fintech companies and other developers in the Kingdom, the CBB has established a regulatory framework that enables them to perform real-time research in a controlled environment under the watchful eye of a regulatory 'watchdog.'

There have been a number of cryptographic protocol entities that have jumped into the virtual world and collaborated with the CBB in screening and optimising their technology-based innovative products, agencies, and systems in a monitored virtual space without being directly constrained by the customary legal and financial prerequisites that would otherwise apply to their own operations since the establishment of the regulatory framework.

The CBB has further established a regulatory sandbox to aid fintech and blockchain startups flourish within the country. The University of Bahrain (UoB) recently stated that it would use blockchain to issue digital degrees. This effort, endorsed by Bahrain's Information and eGovernment Authority, makes UoB one of the first colleges in the world to offer digital degrees.[cxlix] By implementing the aforementioned system, the university attains greater security, as it significantly simplifies the process of checking the legitimacy of the certificate from any global location without having to return to the institution.

The blockchain-based application of the General Directorate of Traffic is a car registration initiative based on the blockchain. By utilising the most up-to-date technology and delivering high-quality car registration services, the application in question facilitates the potential for a stable, long-term and maintainable infrastructure.

The Application Performance Management (APM) terminals are also working with the Khalifa Bin Salman Port (KBSP) operators and other customs agencies and stakeholders to implement blockchain facilities at the port. KBSP is set up with the necessary infrastructure, and once the customs authority completes its blockchain requirements, Bahrain will be included in the blockchain map.

Bahrain's Electronic Network for Financial Transactions (BENEFIT) has started building and implementing a nationwide Know Your Customer (KYC) utility based on blockchain technology.

The most significant event for Bahrain was the adoption of Decree-Legislation No. (54) of 2018, which made Bahrain the first country in the world to establish a law on Negotiable Electronic Records. The law creates the necessary legal framework to facilitate the use of blockchain and other new technology in government and business activities in Bahrain. The legislation and friendly outlook of the regulators in Bahrain have made Bahrain a hub for DLT innovation, attracting the largest global players to Bahrain. The friendly regulatory environment promoting the use of DLT and smart contract use cases has led to Bahrain becoming one of the top jurisdictions for entrepreneurs, companies and blockchain enthusiasts interested in doing business in the middle east.

9.1.4. SAUDI ARABIA

Saudi Arabia has a bold digital transformation strategy detailed in its 'Saudi Vision 2030' project, which involves investments in cutting-edge technologies such as IoT, artificial intelligence, smart cities, and blockchain.

Blockchain industry executives, academic experts, and officials from enterprises collaborating with the Saudi Arabian government discussed the significance of blockchain technology in furthering digital transformation in the Kingdom during the recent Blockchain for Saudi Vision 2030 Summit in Riyadh.[cl] The BSV blockchain was a hot subject during the event due to its huge block sizes, cheap transaction fees, and stable underlying protocol. It provides a scalable and dependable foundation on which the country intends to develop government and enterprise-scale applications.[cli]

The Saudi Arabian Monetary Authority (SAMA) announced the deployment of blockchain to transmit money to save a portion of fluidity injected into the banking sector. By enrolling such technology, SAMA seeks to synchronize itself with the current trends of worldwide banks. SAMA is one of the first central banks within the Arab region to investigate the use of blockchain technology in financial transactions.[clii] This initiative's goal is to promote fintech throughout the Kingdom. Regulatory sandbox launched in collaboration with Fintech Saudi, the Capital Market Authority, the SAMA Regulatory Sandbox, and several digital banking and payment services has created sector-specific regulations and rules that promote innovation in a safe and secured regulatory environment that promotes investor and market protection.[cliii]

Saudi Arabia has also teamed with IBM and Elm to discuss the strategy for using blockchain to provide governmental and commercial services. A number of organisations are already underway with them experimenting blockchain platforms and how they interact with business activities, an example of which includes the "Customs Administration" in Saudi Arabia, which is conducting a pilot study for blockchain in import systems through marine ports using the IBM and Maersk Trade Lens platform. Furthermore, the King Abdulaziz City for Science and Technology conducts and provides basic and specialist blockchain training programs for developers, entrepreneurs, students and blockchain enthusiasts. Saudi Arabia's 2030 goal includes an economic transformation plan that uses blockchain to reduce bureaucracy and expand access to digital services.

9.1.5. OMAN

The Sultanate of Oman began its blockchain endeavour in November 2017 with the introduction of Blockchain Solutions & Services Co (BSS) introduced at the Oman Blockchain Symposium. This organization aims to promote innovation and improve the efficiency of services by utilising the finest distributed ledger platforms while maintaining security.

Oman has been working diligently to implement a comprehensive digitization strategy for the country. Further, there are ongoing discussions surrounding the involvement of blockchain within the private sector as Banks in Oman, such as Bank Dhofar, are working on Blockchain with Ripple. BSS is in collaboration with Oman's Banking Association for blockchain projects. As the next important step toward a comprehensive e-Oman government, the establishment of the Omani Information Technology and Communications Group was advertised by the Ministry of Transport and Communications (MoTC).[cliv]

Salalah port recently joined TradeLens, a blockchain-based digital shipping network, to boost digital client experiences. More than 100 different entities make up the TradeLens ecosystem, including ports, airlines, terminal operators, and more.[clv] In 2019, Oman became the first Arab country to develop a blockchain-based platform for Waqf charity crowdfunding and sharia-based investing.

9.1.6. EGYPT

Whilst the Egyptian government has not stipulated an overarching strategy for adopting DLT, we can see developments and use cases using DLT in Egypt. Misr Technology Services (MTS), Egypt's 80 percent state-owned corporation, has renewed its partnership with CargoX to supply Ethereum blockchain services for the next five years, following the opening of its National Single Window for Foreign Trade Facilitation (NAFEZA) last year.

As part of a national platform that covers Egyptian airports, seaports, land ports, dry ports, and free zones, the CargoX platform will allow digital shipping documents, such as ACI declarations, bills of lading, and other original documents, to be immutably registered and transferred using the Ethereum network.[clvi]

9.2. SMART CONTRACT FRAMEWORK ADOPTION BY THE GOVERNMENTS: CASE STUDIES

Since public administration is responsible for maintaining a country's economic growth as well as setting public policies that promote residents' social and economic well-being, it is one of the most important sectors. However, the existing public administration system is inefficient and sluggish. As a result, it is necessary to incorporate new perspectives in order to regain trust with more transparent, faster, more efficient, and integrated models in citizens' daily lives, which also allows participation and incidence, and in this sense, the blockchain system not only serves for companies seeking benefits, but also for public entities in the fields of education, health, and energy networks.[clvii]

a) *Transparency*

The blockchain system through smart contracts will automate processes and ensure the integrity of transactions, administrative concessions, records, and important decisions preventing officials from hiding payments, official records, or other manipulations from within or outside the system, and favouring greater control, traceability, and transparency.[clviii]

b) *Transnational digital identities - Smart Contract Adoption in Estonia*

Another public-sector use of blockchain is offered by the Republic of Estonia, which has developed an e-government strategy centered on interconnection and decentralisation, openness, and cyber security, making it a leader in digital governance. Estonia recently launched its e-Residency programme, which allows anybody in the globe to seek a "transnational digital identity" and authentication in order to have access to secure services and digitally encrypt, authenticate, and sign documents. The country is now implementing a Blockchain system to facilitate the interchange of various sorts of data between the Public Administration (legal, etc.) as well as its protection, security, and transparency.[clix]

c) *Property Registration- Smart Contract Adoption in Sweden*

Sweden, for one, is planning to develop blockchain-based property registration in the hopes of shortening the time between signing a contract and registering it, and Georgia and Honduras have already adopted the idea.

Germany, South Korea, Ghana, Kenya, Singapore, Sweden, the United Kingdom, Brazil, Japan, the Indian state of Andhra Pradesh, the American state of Illinois, Ukraine, Croatia, Russia, and other countries are in the process of implementing or have already implemented property registration through Blockchain to address similar issues such as fraud, corruption, transparency, and the lack or multiplicity of data on the ground.

d) *Public procurement and Tender Process - Smart Contract Adoption in Spain*

In Spain, the development of blockchain projects for the public sector is in its early stages; the applications of blockchain in government are few; some of them are being developed in the field of public procurement, which is one of the areas that are well suited to "benefit" from the technology. This is the use of blockchain in the register of contractors, which was tendered by the Basque Government's Information Society (EJIE) to the Government of Aragon in January 2018 in order to create a decentralised registry of public contract offers that allow for automated valuation through smart contracts.[clx]

Aside from the contractual initiatives described in the preceding paragraph, the Alcobendas City Council created the "Blockchain technology-based public involvement voting system," the results of which were presented at the IV Congress of Smart Cities in 2018.

Various use cases for smart legal contracts are also provided in the call for evidence of the Government advisory report issued by the Law Commission of the UK, namely Insurance, banking, decentralised finance, real estate, supply chain, peer-to-peer, and intellectual property.

9.3. SMART CONTRACT ADOPTION BY ORGANISATIONS: USE CASES

Traditional contracts, which are defined by low-level automation and physical asset exchange, characterise the existing condition of organisations. Businesses, for example, have a trade/sales agreement, whereas suppliers have a contract with their individual enterprises. All of these contracts are physically and electronically recorded. Furthermore, there is an intermediate, which is frequently a government institution charged with assuring the contracts' successful implementation. The fundamental goal of the intermediary is to guarantee that legally enforceable contracts are created and that any contract breaches by either party are minimised.[clxi]

After the smart contracts are implemented, corporate organisations will be working in a smart world where all contracts are coded to self-execute using numerous blockchain networks. This will improve the company's productivity, financial transparency, and customer service.[clxii]

a) *Accuracy*

The accuracy of smart contracts is one of the benefits that business organisations will get from their use. All information about the contract is written in a conditional fashion, using if-then statements, as discussed in the procedures of putting up a smart contract. For example, if customer x pays x units of y, then immediately credit the recipient of the amount and also open the service package for customer x. Because the bulk of contracts involve the exchange of money. The smart contracts may then be synchronised with cryptocurrencies like Ethereum, Lite Coin, or bitcoin, among others, further enhancing the system's robustness, accuracy, and performance.[clxiii]

b) *Transparency*

The terms and conditions of the contract terms and conditions are virtually apparent to the various network actors of the specific blockchain. As a result, once the contract is in place, it is difficult to make adjustments. Other network nodes on the blockchain monitor and control each transaction by any side of the contract. Transparency is fostered as a consequence, and fraud concerns are eliminated. Various examples have been documented in the contemporary period when an entity has been accused of scamming clients and not providing them with the worth of their money. This provides a very feasible solution to the said problem.

c) *Efficiency and Speed*

Smart contracts, in essence, do not require human interaction and are led and monitored by other nodes in the blockchain network. As a result, the scripted contract self-executes once the contract is activated. When scripting the contact, this is frequently accomplished by using trigger events. A trigger event might be a date, time, or even an activity undertaken by one of the contract parties, such as the transfer of specified cryptocurrency units from the customer's wallet to the company's wallet. When a trigger event occurs, the contract begins to execute itself. For example, once a specified unit of cryptocurrency is received by an online subscription-based organisation, the customer's subscription is automatically renewed.[clxiv]

a) *Cost-cutting*

Essentially, top company executives are tasked with devising cost-cutting plans and methods for their companies because the primary goal of starting a corporation is to make money, all operations in an organisation must be constructed to support the attainment of corporate objectives while also increasing shareholder value. In a world that has undergone a massive technological change, the capacity of commercial companies to stay up with the latest technology and implement measures and practices that boost employee productivity and performance is critical.[clxv]

b) *Safety*

Smart contracts provide one of the greatest security measures. Smart contracts based on blockchain technology take advantage of a decentralised network of non-trusting parties. Because the participants in the network are distrustful of one another, they must keep an eye on one another to guarantee that each transaction is completed successfully and that all transactions have the same status.

10. GUIDANCE FOR SMART CONTRACT ADOPTION

The first step to successful, quick, economic and personalised adoption of DLT technology in any country is to develop a national strategy for the adoption of smart contracts by public and private sector organisations. Because smart contracts are technically, legally, and regulatorily new, it may be difficult to identify the most important parts of such a national plan. In this part, we talk about the difficulties governments may have in implementing smart contracts. After that, the paper outlines possible remedies to these problems, which might be included in DLT policies tailored to individual countries.
For ease of reference, the challenges are categorized into (a) technical and (b) organizational related challenges.

Diagram 2 – Guidance for Smart Contracts Adoption

10.1 RECOMMENDATIONS ON SMART CONTRACT BASED TECHNICAL AND ORGANIZATIONAL CHALLENGES

10.1.1. RECOMMENDATIONS ON SMART CONTRACT BASED TECHNICAL CHALLENGES

a) **Technical immaturity:** It is possible that smart contract protocols and networks are not yet that mature. There may not be enough companies in the Blockchain industry to provide healthy competition since the ecosystem is still developing. As a result, there might be a stall in the growth of technical competence and the production of bug-ridden protocols and protocols that have not been thoroughly stress-tested. As a result, the government-adoption-ready processes may not exist or have not been thoroughly evaluated.[clxvi]

***Proposed solution*:** Governments may determine how to strike a balance between domestic and international smart contract development and implementation standards. Therefore, they might provide motivation to pursue these objectives.

b) **Risk of vendor lock-in:** In certain countries, the smart contract solution may be hard to get by due to a lack of qualified providers. As a consequence, it is possible to become too reliant on a single seller. Due to this, smart contracts deployed may also be vulnerable to security and privacy problems and lack of market competition, which might hamper the product's development.[clxvii]

***Proposed solution*:** Incentives targeted at domestic and international service providers may be created by governments to encourage them to set up operations in their country.

c) **Inadequate scalability:** Existing smart contract systems' scalability may not be enough for government use. Government transactions that may gain the most from smart contract technology may run into this issue. In financial transactions, for example, great volume and high throughput are required.[clxviii]

***Proposed solution*:** Governments may release scalability metrics, and suppliers may be invited to submit bids if they claim to meet these criteria. Aside from smart contract-based networks, governments may look at other technological options, such as directed acyclic graphs-based smart contract networks.

d) **Privacy:** A private smart contract-based network limits read and write access to network members who have been granted authorization. The network's members may be able to view data that has been accepted by other approved members, raising questions about member privacy.

***Proposed solution*:** Smart contract solutions that structurally fix this problem may be investigated by governments. An example of this is R3's Corda and Hyperledger Fabric, which is a DLT-based smart contract product.

e) **Lack of interoperability/ compatibility:** There is the possibility that a national smart contract platform may be hindered if the smart contract networks of different government agencies or sub-departments cannot communicate with one another. If this is allowed to continue, the government departments might become isolated entities.

***Proposed solution*:** On-chain and off-chain interoperability frameworks, such as a shared smart contract protocol, might overcome this problem.

f) **Lack of native technical expertise:** Some nations may lack smart contract-related technical competence because of its infancy. This might be a problem for governments that do not want to rely on foreign suppliers for their smart contract development.

***Proposed solution*:** A solution to this problem might be to offer domestic, application-oriented certification programmes or training courses in smart contract development. Government agencies may give this to their workers or the public. Nations may also investigate similar educational initiatives. As a result of this, it is possible to gain native smart contract development-based technical skills.

g) **Absent support infrastructure:** Governments may be reluctant to implement smart contract solutions because of the issues outlined in the previous sections. In addition, the high maintenance expenses of cloud processing, storage, server farms, and networking equipment may make this an unaffordable option.

***Proposed solution*:** If governments are interested in supporting blockchain technology adoption, a wide range of options are available. These may include but are not limited to help with server set-up, power and land rebates, tax refunds, and cash incentives.[clxix]

10.1.2. RECOMMENDATIONS ON SMART CONTRACT BASED ORGANIZATIONAL CHALLENGES

a) **Governance related concerns:** It is comparable to how corporations or consortia split their tasks among themselves when it comes to smart contract-based blockchain governance. The smart contract network's many roles must be examined by government agencies, for example, who will be responsible for implementing code modifications, maintaining nodes, or debugging the smart contract protocol.[clxx]

***Proposed solution*:** Governments may want to determine whether they can learn about smart contract governance and development on their own, or if they want to bring in outside help.

b) **Regulatory and legal concerns:** The legal and regulatory frameworks for the use of smart contracts and associated technologies are still being developed in the majority of nations throughout the world. It is possible that contracts recorded on distributed ledgers will not be enforceable in court. That smart contract-supported e-commerce transactions will not be recognized in most countries. Licensing, authorizing, and approving smart contract solutions may also lack regulatory frameworks. Uncertainty may arise due to the absence of a formal regulatory framework.

***Proposed solution*:** National smart contract policies' legal and regulatory frameworks should be examined to see if any legal and regulatory gaps need to be filled. To ensure that these rules are easy to understand and apply and to reduce the likelihood of conflicts, they should be kept basic and avoid overlapping with current laws.

a) **Complexities in integration with legacy systems:** If the process of integrating smart contracts with existing systems is time- or money-consuming, government agencies may be reluctant to use the technology.[clxxi]

***Proposed solution*:** It is possible that governments may look at hybrid integration approaches, which use both on- and off-chain solutions. In addition, this integration may be accomplished in a time and cost-effective manner.

10.2. RECOMMENDATIONS ON PUBLIC-PRIVATE PARTNERSHIP FOR SMART CONTRACT ADOPTION

Governments must focus efforts on exploring fruitful public-private collaborations to realize the full potential of smart contracts, whether in governance or otherwise. Here are some ways in which governments could leverage private sector participation in the field of smart contract development.

a) **Academic interventions:** Governments, businesses, and academics may work together to plan conferences, roundtables, and other smart contract-related events on an annual national basis. Events with predetermined results benefit from having a yearly calendar that promotes predictability and makes it easier to participate locally and worldwide. The private sector has enough time to gather professionals from across the world. This would make it easier for governments to share information, goals, and progress.

b) **Talent identification programs:** Governments and the private sector may work together to boost talent-hunting initiatives. The government and industry, respectively, might set up incubators and accelerators. Additionally, this would increase the domestic workforce's capacity. [clxxii]

c) **Pilot Projects:** Governments may work with the business sector on a variety of initiatives. The Australian, Estonian, and Indian governments have launched many pilot projects to encourage greater cooperation between public and private sectors.[clxxiii]

d) **National Smart Contract Platforms** – Using government-created cloud-based smart contract platforms to manage and provide smart contract-based services is possible for both the public and private sectors.[clxxiv]

e) **Funding for research:** Smart contract innovation may be encouraged through government funding and incentives for the corporate sector and academics. When it comes to blockchain innovation, Australian government initiatives like Austrade business missions to international markets and a grant programme for aspiring entrepreneurs and the Australian Research Council Grants have been instrumental in helping the public and private sectors collaborate on blockchain smart contract development.[clxxv]

f) **Ecosystem creation:** Smart contract enthusiasts, blockchain enthusiasts, IT professionals, academics, and students from all walks of life may work together to create an ecosystem where valuable information and knowledge can be shared.[clxxvi]

10.3. RECOMMENDATIONS ON SKILLS & AWARENESS AND SCOPE OF JOB CREATION

Further, we will look at how skill development and job creation may be pushed in the smart contract sector in this part of the policy paper:

a) **National platforms to locate opportunities:** In order to provide students with real-world experience, governments may offer forums for academic institutions and businesses to interact. Internships and shadowing by individuals in the field may be used to accomplish this. Smart contract implementation and problem-solving abilities would be strengthened in this way.[clxxvii]

b) **Academia-industry collaboration for research:** There may be an incentive for universities and technical institutes to collaborate with technology businesses to research smart contracts. As a result, future smart contract-based projects might benefit from the development of new solutions and the strengthening of existing ones.

c) **Focus on STEM (Science, Technology, Engineering, Mathematics):** In order to guarantee that the national smart contract ecosystem may expand in the future, STEM initiatives should be implemented to improve the competency of students in these fields.[clxxviii]

d) **National list of DLT related skills:** Smart contract-related abilities and training may be broken down into three categories: Beginner, Intermediate, and Advanced. Core blockchain development, smart-contract creation, decentralised governance, DLT integration and deployment, DLT product testing, auditing, and so on are examples of specialised knowledge that may be offered. The material for these trainings will be developed by domestic professionals and academics, who will play an important role.

e) **National databases:** Material, efforts, and opportunities related to smart contracts must be communicated to the right people. Smart contract enthusiasts, stakeholder groups, and practitioners might be educated by building a national knowledge resource in their native language.

f) **Smart Contract-centric courses, certifications, and MOOCs:** Courses, certificates, MOOCs, and short-term programmes specialising in smart contracts may be developed by government skill development agencies or nationally financed educational institutions. For example, professionals in law, accounting, and medicine may be targeted by these initiatives since they will need to become familiar with smart contract solutions and their ramifications (such as data preservation difficulties) as well as their practical implementations.

g) **Competitive platforms:** Governments could develop themed "hackathons" for start-ups to identify and promote smart contract applications through innovation and entrepreneurship activities. These may take the form of start-up competitions, entrepreneurship weekends on transforming business models, digitising processes and data integrity. The objective may be to leverage smart contracts to solve societal challenges by bringing innovative business models to the spotlight, enabling and supporting disruptive scenarios for driving growth and addressing inefficiencies.

11. GUIDANCE ON ASSOCIATED RISKS RELATED TO SMART CONTRACTS

Being a new technology, smart contracts confront several hurdles, including legal issues, dependency on "off-chain" resources, immutability, scalability, and consensus process issues.

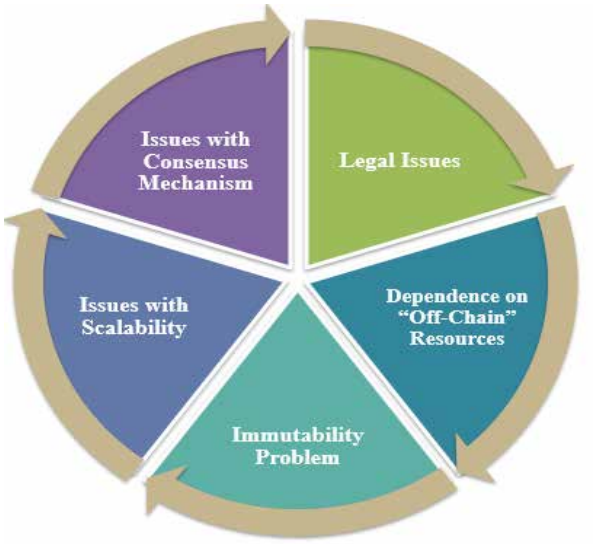

Diagram 3 –Smart Contract Challenges

a) *Legal Issues*

An important part of smart contract difficulties is the legal aspect of smart contracts. Data protection regulations in Arab states nay provide citizens with the "right to be forgotten", which contradicts the immutability of blockchain-enabled smart contracts. Other legal issues include: each country has its own laws and regulations, making it difficult to ensure compliance with all of them; (ii) law clauses or conditions are not quantifiable, making it difficult to model these conditions in smart contracts in a way that is appropriate and quantifiable for a machine to execute them; and (iii) governments are often interested in a regulated and controlled use of blockchain technology in a variety of applications.[clxxix]

b) *Dependence on "off-chain" resources*

Several smart contracts require data or parameters from resources that are not part of the blockchain, known as off-chain resources. Oracles are utilised as trustworthy third parties for this purpose, retrieving off-chain information and pushing it on the blockchain at predefined periods. Although current oracles have been thoroughly tested, their usage might add a "point of failure." For example, an oracle may be unable to supply the essential information, offer incorrect data, or cease operations. As a result, smart contracts will need to account for these scenarios before they can be widely used[clxxx].

c) *The Immutability Problem*

The attribute of immutability is a key element of smart contracts. The code of a smart contract cannot be modified once it has been deployed. The evil side of the immutability idea of smart contracts, on the other hand, is that in the case of any coding flaws, the immutability aspect of a smart contract prohibits them from being corrected. Similarly, there is no straightforward way to alter a smart contract if circumstances change (e.g., the parties have mutually decided to change the conditions of their

commercial arrangement, or if the law changes, etc.). As a result, rigorous and potentially costly expert assessments of the smart contract are necessary prior to its deployment in a blockchain.[clxxxi]

d) *Issues with Scalability*

Many blockchain networks are concerned about scalability. For example, the Ethereum blockchain can only validate 14 transactions per second, but Visa can process up to 24,000 transactions per second. Indeed, the scalability issue causes network congestion, higher transaction commission costs, and a longer time to process transactions. Future research concentrating on raising the number of transactions per second by smart contract platforms will be necessary to overcome the scalability issue.

e) *Issues with consensus mechanism*

The consensus mechanism is critical for maintaining security, scalability, and decentralisation in blockchain networks. Proof-of-Work (PoW), Proof-of-Stake (PoS), and other consensus techniques are already in use. Although the PoW method provides blockchain security, it consumes resources. As a result, many enterprises are switching away from the PoW algorithm in favour of alternative consensus mechanisms that offer cheaper transaction fees and lower energy costs for the block manufacturing process. As a result, future research can test novel consensus methods like proof-of-activity (PoA) or delegated proof-of-stake (DPoS) in order to increase their quality.[clxxxii]

12. RECOMMENDATIONS ON MANAGING RISKS ASSOCIATED WITH SMART CONTRACTS

The adequate handling of the risks associated with any new technology is critical to its successful adoption and operation. This is especially true when the technology is more than an app and is part of the organization's fundamental infrastructure. In the near future, smart contracts have the potential to provide the backbone of many fundamental systems. Therefore, governments should aim to map out the risks associated with smart contracts and their adoption and implementation. Smart Contract testing could also be helpful to mitigate the risks associated with Smart Contracts as it would validate the actions of the smart contract and offer the assurance that the code does what the organisation wants it to do and does not do what they don't want it to do. Tests ensure that newly introduced code does not have unforeseen consequences on development. Refactoring is much easier with a solid test suite. Debugging takes less time using tests. When an unexpected problem occurs, the test suite helps to eliminate a number of possible reasons quickly.

Further, an audit and smart contracts assessment must be examined in depth. These are necessary in order to protect monies invested through them. They cannot be recovered if monies are hacked or stolen since all blockchain transactions are final. Auditors will often evaluate smart contract code, write a report, and hand it over to the project. After that, a final report is sent, documenting any remaining mistakes and the work that has already been done to resolve performance or security concerns. These measures would help in successfully managing the risks posed by smart contracts.

12.1. RECOMMENDATIONS FOR MANAGING SMART CONTRACT RISK

Hackers may take advantage of many security flaws in most blockchain systems. However, these difficulties may be resolved during the development stage of smart contracts. These problems can only be solved if the best practices are followed with no room for error or unforeseen occurrences.

Writing secure smart contracts on various platforms and programming languages requires adherence to best practices.

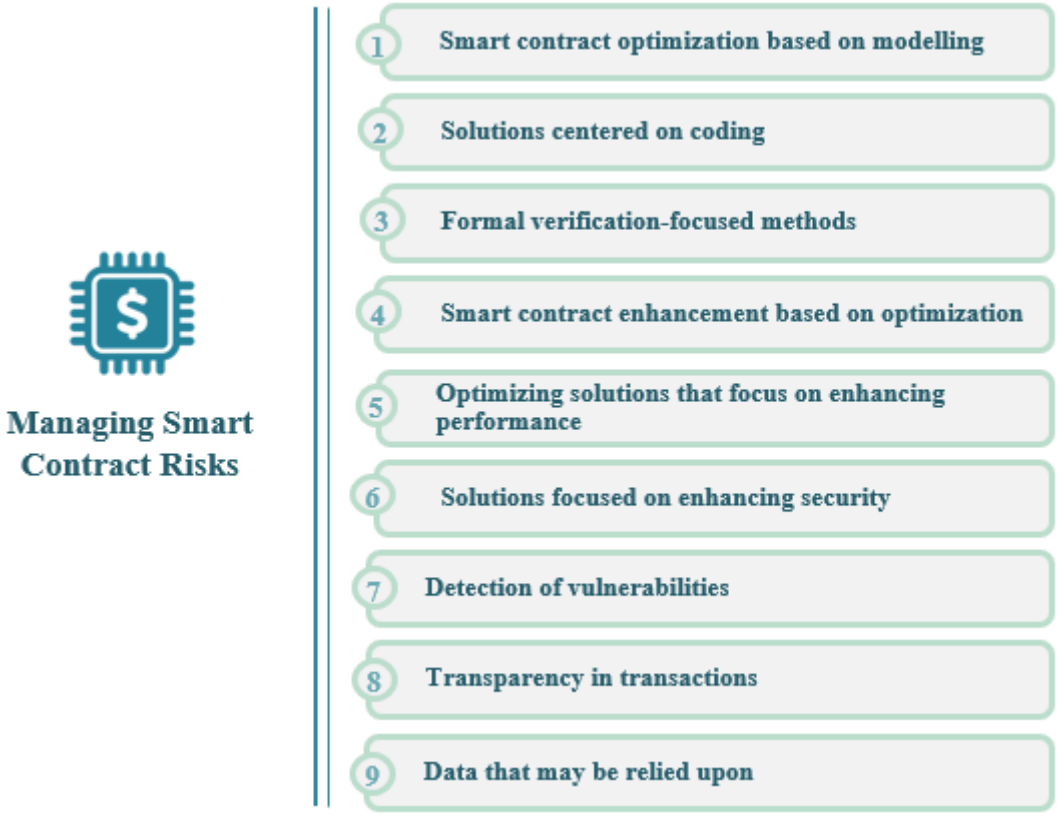

Diagram 4 –Managing Risks Associated with Smart Contracts

a) ***Smart contract optimization based on modelling***

Several security flaws in smart contracts have led to massive theft and financial losses in the last few years. Prior to placing such smart contracts on the blockchain, formal study and verification may have prevented these issues. Several academics have suggested alternate techniques to enhance smart contract functionality verification since current programming languages like Solidity are not suited for formal verification.[clxxxiii]

b) ***Solutions centred on coding***

In order to understand smart contracts, it's critical to understand how to write computer code that can be automatically run on a computer. Several experts have claimed that inventing new contract languages is the best method to ensure that a smart contract is written correctly.

New contract languages promised that they would remedy the weaknesses in the current domain-specific language. However, since they haven't been tested in the field, they may have flaws. Adaptive software engineering technologies and knowledge from several academic disciplines, including networking, programming languages, formal techniques, and cryptography, are still required to design and implement safe smart contracts.[clxxxiv]

c) *Formal verification-focused methods*

There are a number of ways that formal testing may be used to guarantee that a piece of software is doing exactly as it should. Truffle is an example of an Ethereum development framework for smart contracts that allows the creation of formal test cases for smart contracts written in JavaScript or Solidity based on specific mathematical logic and rules.[clxxxv] Using JavaScript, these test cases may be constructed and run on a test network to verify the various characteristics of smart contracts. Formal testing cannot help developers identify faults or weaknesses in their code. In order to ensure that smart contracts are functionally valid, automated formal verification is a promising strategy for finding bugs and other mistakes. Formal verification can provide the most assurance that smart contracts behave correctly. Various scholars have extensively utilised formal approaches to verify smart contracts, with notable outcomes in practice. As an example, Amani et al. augmented an existing formalization of the EVM in Isabelle/HOL with a sound programme logic at the bytecode level.[clxxxvi] In this approach, the bytecode sequences are organized into linear code blocks and a logic programme is created, where each block is handled as a set of instructions. A single trustworthy logical framework is used to verify each aspect of the verification.

When it comes to testing, formal verification technologies are still in their infancy. Since smart contracts are so complex, the formalization of smart contracts is an important research area that gives the maximum degree of confidence in their right behaviour. The application of smart contracts in vital systems, such as financial, healthcare, and banking systems, may benefit from real development in this study area.

d) *Smart contract enhancement based on optimization*

It is now possible to design completely decentralized apps without the need for a trusted third party due to smart contracts. Despite the positive aspects of smart contracts, a number of obstacles, including performance difficulties, security risks, and privacy concerns, continue to obstruct their widespread implementation. Aside from security and privacy, new smart contracts' execution time and cost are more stringent. This section will talk about ways to enhance smart contracts via optimization, which we will divide into two broad categories: performance optimization and security optimization.

e) *Optimizing solutions that focus on enhancing performance*

Systems that can deliver in a fair amount of time and maintain performance as the number of contracts grows are known as smart contract performance systems. Throughput bottlenecks, restricted scalability, and transaction delay are just a few of the performance problems that blockchain systems face. Some academics have devised ways to improve smart contract systems' performance by executing contracts in parallel rather than sequentially. While Gao and colleagues have proposed an algorithm for partitioning smart contracts into multiple subsets using integer linear programming and assigning subsets to subgroups of users, many other techniques can be used, such as a random assignment protocol for assigning a subset of contracts to a subgroup of users. Other research has been suggested optimizing smart contracts by reducing gas use. Smart contract execution is interrupted when it surpasses a quantity of gas (known as the gas limit) known as the out-of-gas exception. One example is the automated detection of EVM operation sequences that can be replaced with operations that have the same semantics but use less gas and then replaced with efficient code.

f) ***Solutions focused on enhancing security***

In order to ensure the safety of a smart contract, it must be impervious to assaults from malevolent users that want to benefit from the contract's security flaws or leverage the absence of reliable data feeds to introduce harmful data.

g) ***Detection of Vulnerabilities***

To increase the security and integrity of contracts, it is critical to identify possible weaknesses in contract execution. Several studies have thoroughly documented and examined the security issues associated with contracts. A taxonomy of smart contract vulnerabilities, for example, has been published by Atzei et al. for the three layers of smart contract vulnerabilities, which are Solidity, EVM, and Blockchain. The Decentralized Autonomous Organization (DAO) assault, which stole about 2 million Ether from a smart contract by exploiting a re-entrancy flaw, has become the most well-known in recent years. When an attacker managed to modify the block hash of the SmartBillions' lottery function twice, he managed to acquire 400 Ether in his favour, making it a completely decentralised lottery system. Several strategies for detecting vulnerabilities in smart contracts have been presented to address the issues raised by these contracts. Certain research has found remedies to common vulnerabilities, such as Oyent, SmartInspect and ContractFuzze. ReGuard[clxxxvii] and EthRacer[clxxxviii] are two examples of work that focuses on particular vulnerabilities, such as re-entry issues and event-ordering problems.

h) ***Transparency in transactions***

Keeping important operations hidden, using encryption, and avoiding the public disclosure of data on the blockchain is a serious difficulty for smart contracts. Smart contracts' widespread adoption might be hampered if they lack transactional privacy. Hawk, a decentralised smart contract system, has been suggested by Kosba et al. to solve this problem. Smart contract developers may use Hawk to create contracts that protect their clients' privacy without having to use any encryption. Cryptographic primitives like as zero-knowledge proofs are used by its compiler to automatically construct an efficient cryptographic protocol for contractual parties to communicate with the blockchain.[clxxxix]

i) ***Data that may be relied upon***

The execution of a smart contract needs some outside information about real-world conditions and occurrences. To construct a connection between the blockchain and the outside world, Oracles (also known as data feeds) are needed (e.g., Web API). For example, Zhang et al.[cxc] have presented Town Crier, which connected current generally trusted non-blockchain based websites and smart contracts to supply authenticated data to smart contracts while retaining anonymity using encrypted parameters.[cxci]Suppose a smart contract receives malicious code or poor data. In that case, it processes it as is and generates an erroneous and unexpected result. As a result, oracles maintain a great deal of control over the execution of smart contracts, as the data they give is what makes the contracts work.

To sum up, recent years have seen a rise in research to increase the security and performance of smart contracts. Smart contracts that rely on each other must be executed in parallel if they are to speed up contract execution. As a result, smart contract code optimization may effectively decrease contract vulnerabilities while ensuring efficient and safe contract implementation. Although present studies are still in their early stages, new vulnerabilities or defects cannot be discovered and replaced. As a result, further study into smart contract optimization is required.

13. KEY FINDINGS AND STEPS FORWARD

Smart contract applications benefit financial market participants in terms of execution speed and transaction costs. The deployment of DLT-technological innovation to disintermediate financial services may be the driving reason behind these efficiency benefits. If the governance arrangements and costs associated with transaction resolution on the underlying DLT or blockchain are appropriately implemented via smart contracts, stakeholders may be able to benefit due to the efficiency of scale. Smart contracts facilitate financial innovation and may potentially promote financial inclusion, depending on the architecture and transaction arrangements, due to the open-source nature of the protocols.

The absence of regulatory or supervisory access points in decentralised smart contract networks is one of the primary policy challenges that must be addressed. Regulators and supervisors may need to recentralize smart contracts for the time being, but decentralization will not be destroyed entirely. A balance between full absence of central control and thorough monitoring may be reached by holding one party accountable, such as protocol developers or other incentive parties. Identifying regulatory and supervisory access points in the context of community consensus may appear contradictory given the Smart contracts market ethos. The challenges with smart contracts might be solved by a centralized government or other forms of centralization. DAO governance structures, which incorporate centralized attributes like the admin key or concentrated ownership of governance tokens, might serve as a regulatory and supervisory control point. The legal entity or users who profit from the operation of smart contracts services through profit-sharing mechanisms or fees may be regulated as per national and international regulatory frameworks in line with AML and CFT regulations.

Due to the unique elements of financial service delivery in decentralized systems, potential regulatory gaps may arise, posing additional dangers. Regulatory arbitrage in the processing of Smart contracts services may be possible if these gaps are not addressed. If prudential and investor protection mechanisms are not in place, smart contracts, for example, may be vulnerable to over-leveraging and other financial risks. Some regulatory methods employed in centralized settings may need to be rethought to be compatible with decentralised organisations. Due to the technological peculiarities of decentralized systems, extra restrictions may be required. Further, the determination of the legal treatment of smart contracts needs to be established either by state or judiciary intervention.

Policymakers should be more active in fostering greater collaboration among all parties involved in blockchain-based financial systems to develop a cooperative climate among stakeholders. The code included in DLT systems may contribute to the argument over how to properly supervise the activities of a blockchain-based financial ecosystem, and the engineering and software development communities should be involved in this discussion.

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