Foundations of Blockchain, Cryptocurrencies, and Smart Contracts

KAN-CDSCV1001U

Decentralized Crowdfunding Platform Driven by Blockchain Technology

Revolutionizing Conventional Crowdfunding Platforms in the era of DeFi

Authors:

Alisa Ilina 141804
Simon Berner Borch 118868
Simon Sardorf 141484

Supervisors:

Raghava Mukkamala
Somnath Mazumdar

Pages: 13

Number of characters: 28.931

Source Code: https://git.io/JDB8a

14 December 2021

Abstract

Blockchain technologies are disrupting markets, unleashing the potential of various decentralized applications benefitting economies and societies. The aim of the paper is to implement a decentralized crowdfunding platform built using blockchain technologies, and evaluate the implications it can bring to the crowdfunding economy. By analyzing the inefficiencies of the conventional crowdfunding market, such as information asymmetry, proneness to fraud and mismanaged funds, we conceptualize a use case for a decentralized platform. We outline relevant stakeholders and their requirements to better adapt to solving the outlined challenges. The development of the designed smart contract, testing, deployment, and interaction through frontend are elaborated upon. The implications of the transition towards decentralised crowdfunding, such as cost-efficiency, increased trust and transparency, the negligent need for governance yet debatable legal implications, are analyzed. The designed platform can provide an organized and secure place for stakeholders to build and invest in new projects. The findings show that blockchain is embracing the new era of crowdfunding by empowering the democratization of fundraising and unlocking the next generation of decentralised finance.

Keywords: Blockchain Technology, Smart Contract, Crowdfunding, dApp, DeFi

Table of Contents

1. Introduction

Nowadays, in pursuit of greater returns of value, the society and technological advancements are shifting towards novel solutions, with decentralised applications (dApps) capable of mitigating the intermediaries, cutting costs and entering the spotlight of technical attention. In the past few years, blockchain and smart contract technology have emerged as a new way to build trustworthy and secure digital platforms. Blockchain technology is a distributed ledger technology that allows for secure, transparent, and tamper-proof transactions. It enables peer-to-peer systems built with trustless asset management, unleashing the potential for crowdfunding projects and disrupting traditional business models. Smart contracts are computer protocols that facilitate, verify, execute and enforce the negotiation or performance of a contract. These technologies have many potential applications in a wide range of industries, with crowdfunding being no exception. Schwienbacher and Larralde (2010) define crowdfunding as "*an open call, essentially through the Internet, for the provision of financial resources either in form of donation or in exchange for some form of reward and/or voting rights to support initiatives for specific purposes*".

Despite the efficiency and high reach of crowdfunding, it is limited with some potential risks such as locked-in investment, lack of information, lack of regulation, proneness to fraud, and slow completion (Startups, 2021). According to the literature, blockchain crowdfunding has the potential to become a new model for fundraisers to raise money from public investors (Yu, C. et al., 2021). Using blockchain and smart contracts can ensure automatic execution and insurance of crowdfunding projects and alleviate the risks of conventional crowdfunding platforms. Therefore, it is highly relevant and motivating to investigate how conventional crowdfunding can be optimized using blockchain technology.

New blockchain projects are being started every day, and like for any business, capital is required to get the business off the ground and attract financial, social and technological traction. The most common form of capital-raising in the crypto market happens through Initial Coin Offerings (ICOs), which is the alternative to crowdfunding in the blockchain space. Investors receive unique tokens in exchange for the capital they provide the business.

Thus, the goal of this project is to create a blockchain-driven platform that allows ICOs and other forms of blockchain projects to be accessible to the masses. A proper implementation of a platform such as this could be highly beneficial for the crypto community, as it would work towards eliminating scam projects (rug-pulls) and other malicious intentions, as more than $80 million are lost every year due to fake crypto schemes (Banafa, 2021). This platform will provide a holistic view of the crowdfunding process and increase trust, accountability and operational transparency.

Additionally, as the adoption of blockchain technologies is still limited to a niche set of systems, the project seeks to contribute to the gap in the existing literature. Opening up the spectrum of possible use cases for blockchain technologies can help mature the technology and increase mass-adoption. Based on this premise, we aim to answer the following research question:

How can a decentralized crowdfunding platform be developed using blockchain technologies and what are its implications?

2. Methodology and Concepts

The following section presents an overview of the concepts and methods essential for the project and addressing the research question. The logic behind smart contracts is elaborated upon, understanding of which is a crucial foundation for developing the platform. Moreover, notations of crowdfunding and ICOs are investigated. The chapter ends by diving into dApp and DeFi which act as the overarching concepts throughout the paper.

2.1 Smart Contracts

Smart contracts were first proposed by Nick Szabo in 1994. He defined the term "smart contracts" to describe a computer protocol that could programmatically execute elements of a contract. Szabo noted that smart contracts could reduce the need for lawyers in the instantiation of a contract and reduce the risk of fraud. When a smart contract is executed, the program verifies the conditions of the contract and then executes the transactions specified in the contract. Smart contracts are transparent and immutable, meaning that they are publicly visible and cannot be changed once they are executed (Szabo, 1994).

Ethereum is one of the most popular blockchain for creating smart contracts. According to Ethereum (2021), the contracts are permissionless, meaning that anyone can write smart contracts and deploy them to the network. Nevertheless, smart contracts have certain limitations, for instance, smart contracts are not suitable to handle ambiguous scenarios. In a fundraising context, partially funded campaigns could result in ambiguity conflicts, therefore the platform developed in this project will disallow partial funding, to circumvent this limitation.

The first building stone in developing the dApp smart contract was to choose a language from a variety of options including Solidity, Vyper, Yul. Solidity was chosen as it is both the most mature and popular language. Solidity is an object-oriented, high-level language, which can be deployed to interact with the Ethereum Virtual Machine. While Solidity is the most mature language out of the possible options, it is still under development, and a lot of the functionalities might break between versions. Our implementation uses Solidity version 0.8.4 and some of the functionalities will not work with earlier versions.

2.2 Crowdfunding & Blockchain

While the crowdfunding scene as a whole has not migrated to a decentralized system, in the cryptocurrency ecosystem, a decentralized crowdfunding approach that has been widely adopted is the Initial Coin Offering (ICO). According to Jan Damsgaard (2021), "*An ICO is a method of raising capital that is particularly often used within the cryptocurrency world. (...). An ICO is a kind of crowdfunding where a number of certificates are offered for sale.*" When the campaign is created, a capital goal will be set for the project to be successful. If the capital goal is reached, the certificates bought by the campaign backers will be exchanged to coin/token, however, if the goal is not reached, the money will be returned to the campaign backers (Investopedia ICO, 2021). It is important to understand what the campaign backers are buying from ICO's, as they are often compared to IPO's (Initial Public Offering – offering shares of a private corporation), "*Investors are not buying the shares of the legal entity but the tokens that are to be created by the software*" (Chuen, D. L. K., 2018). ICO's can therefore also be referred to as token sales. The payment to the ICO's usually happens with fiat currency or through cryptocurrencies such as Bitcoin or Ether. Some of the more known previous ICO's are Ethereum, which was kickstarted with an ICO in 2014 and Filecoin which was initiated in 2018 (Damsgaard, J., 2021).

2.3 Decentralized Applications (dApps) and Decentralized Finance (DeFi)

According to Raval, S. (2016), "*A new model for building massively scalable and profitable applications is emerging. Bitcoin paved the way with its cryptographically stored ledger, scarce-asset model, and peer-to-peer technology. These features provide a starting point for building a new type of software called decentralized applications, or dApps.*" DApps are believed to have a huge potential and disrupt the way we use the internet today, as they are more flexible, transparent, distributed, resilient, and have a better incentivized structure (Raval, S., 2016). Therefore, a decentralized application is essentially an application that is not controlled by a central authority. Instead, it is controlled by a network of computers that work together to keep the application running. This makes it difficult for a single party to control the application or the data it contains, creating a more incentivized structure. According to (Cai, W. et al., 2018), this structure is the ultimate way of structuring a blockchain based application, "*the ultimate blockchain application should be a dApp that is completely hosted by P2P blockchain system. Ideally, a deployed dApp will need no maintenance and governance from the original developers. In other words, an ideal blockchain application or service should be operable without any human intervention (...)*". According to Raval, S. (2016), dApps are characterized by four properties being Open Source, Internal Cryptocurrency Support, Decentralized Consensus and No Central Point of Failure. DApps are generally accessed using web3 and a Metamask digital wallet which facilitates interaction with blockchain on Ethereum, therefore the same setup has been implemented in our dApp.

Despite the possibility of creating dApps tailored to any industry and service, their most common application revolves around decentralised finance (DeFi). Together, DeFi dApps lower barriers of entry into the new generation of financial tools due to transparency and continuous cost-efficient activity. Presenting a novel alternative to traditional finance, they are rapidly accelerating in popularity due to the transparent, trustless, and immutable nature of blockchain. They are embellishing the blockchain functionality and carving the way to the paradigm shift towards decentralised financial models. The modularity and ease of use for the users resulted in a "money lego" metaphor of DeFi dApps, the new building blocks of finance (Cryptopedia, 2021).

3. Conceptual Design

In this section, we will elaborate on the conceptual design of the crowdfunding platform. First, we will analyse how the challenges of the conventional crowdfunding platforms can be solved with a decentralised platform, thus building the motivation for the use case. Hereafter, we will elaborate on the use case by describing the stakeholders of the crowdfunding platform, and presenting the platform setup.

3.1 Addressing the Challenges of Conventional Crowdfunding

Our crowdfunding dApp provides a novel way of funding a project by raising cryptocurrency donations from contributors via public Ethereum blockchain technology without the need for any middleman to manage the data flows. Several major challenges of conventional fundraising can be mitigated with the use of these technologies. In terms of digital payment security, conventional fundraising, despite enforcing strict policies to secure the digital payments, is still prone to cyberattacks. Built on top of the Ethereum blockchain, our system of fundraising inherits all of its properties, such as cryptographic security, transparency and decentralization.

Furthermore, due to the lack of transparency, many crowdfunding projects have been revealed to be either a scam or the funds have been heavily mismanaged. Information asymmetry and the principal-agent problem of conventional crowdfunding could result in adverse selection and even overall failure of the crowdfunding market. Traditionally, such market inefficiencies are attempted, often unsuccessfully, to be mitigated by intermediaries. In the crowdfunding dApp, all transactions will be stored on the blockchain and therefore complete transparency of the platform will be secured making crowdfunding less prone to fraud. Information is directly verified on the dApp, eliminating the need for trusted third parties, thus ensuring security and control of the actions of stakeholders.

Lastly, blockchain allows global contribution as anyone worldwide can contribute with convenient and dynamic transactions. This is of paramount importance for unstable currencies and poor countries, as it addresses censorship and privacy. Conventional funding was exposed to scandals of blockade of donations from certain demographic groups (Nast, 2021). DeFi and dApps, on the other hand, can circumvent this and protect the stakeholders from censorship.

3.2 Stakeholders and the Use Case

For designing the system, the stakeholders, their requirements, as well as their interaction with the system are outlined. Next, the technical implementation section is elaborating upon the technicalities that allowed the design decisions to come into fruition.

In the system, we allow Campaign Creators (CCs) and Campaign Backers (CBs) to interact through the creation and funding of blockchain related projects. In its most fundamental form, CCs are able to create projects that they seek funding for, whereas the CBs can back the projects they find intriguing. To make these interactions seamless, we develop a frontend that interacts with the blockchain and, by extension, makes our deployed smart contract possible.

When a new project is created, the CC will give it a title, a deadline, and a funding goal. CBs can choose a project they believe in, and contribute by investing a certain amount of cryptocurrency into a project. The contract will be fully automated with the help of Solidity and no centralized third party will be required for the process. If the funding goal is not reached, the contributors will get their money back. Therefore, CCs are incentivised to heavily consider what would be a reasonable amount of funding required for their project. Funds will be held in smart contracts and after successful completion of the campaign, the CCs will be able to withdraw the automatically transferred funds to their personal wallets.

4. Technical Implementation

We split the technical implementation into three phases representing the stages we experienced when building the system. The first phase concerns the design and creation of the smart contract, the functionalities and capabilities of it, as well as the limitations of the interactivity. The second phase revolves around the deployment of the smart contract to the chosen blockchain network, as well as the testing environment we utilized to build tests allowing us to make sure the contract functioned as initially imagined. The final phase pertains to the bridging between the blockchain and our frontend implementation, the choices we made regarding this, and some of the implications of these choices. An installation guide for local deployment of the project can be found on the GitHub repository(Appendix A.)

4.1 Building the Smart Contract

To initialize the contract, we do not use a constructor function, as no initial information is required. Instead, we instantiate an array of structs that represent the projects. Each project defined will contain the following fields: `project name`, `deadline`, `funding goal`, `current funding`, `completeness`, `creator` and `supporters` (Figure 1). We define a function `CreateProject()`, allowing for the creation of new projects. Because external users need to be able to call this function, we give it the `External` modifier. Normally, when defining fields in a smart contract, by giving them the `Public` modifier, Solidity will automatically generate a getter function, however, with an array (such as the array of projects), Solidity does not automatically generate a getter function, despite it being public. This is because arrays can theoretically scale to infinity, and Solidity advocates accessing arrays through indexes. While we are aware of these recommendations, we manually create a getter function, `getArr()`, for the array, in an effort to make fetching the data easier in the frontend.

```
struct Project {
    string projectName;
    uint256 deadline;
    uint256 fundingGoal;
    uint256 currentFunding; // defaults to zero on project creation
    bool complete; // completeness status
    address payable creator;
    address[] supporters;
}
```

Figure 1: Defining the Project

We create a `newDonation()` function to allow CBs to make new donations and support projects created. The function takes a single argument index*,* corresponding to the index of the project that a user wishes to donate to (this is further expanded upon in the section detailing the frontend).

The following two requirements are set for the new donations: (1) New donations must not exceed the funding goal, and (2) The timestamp of the donation must not be past the project's deadline. The deadline requirement signifies that a user should not be able to donate to a project that has already ended. The reason for the restriction of not exceeding the funding goal is, as previously stated, because our system seeks to advocate setting a reachable and achievable funding goal, and limiting the funding to that.

The `newDonation()` function has the `Payable` modifier, meaning that users can attach Ether to their message with this function. Ether will then be added to the pool of funding, belonging to that project. When a user donates to a project, their address is also added to that project's list of supporters, keeping a track of who has donated, so that withdrawal is possible if the project fails to achieve its funding. Once a new donation is added, the contract will also check whether the project has reached its goal. If it has, the project's complete field will be marked `true`, otherwise, it will remain unchanged.

Finally, we define a function `payCreator()` that allows CCs to withdraw the funds once the project has reached its goal. Similarly to the previous function, it takes a single argument `index`, corresponding to the `index` of the project. It has a single requirement, namely, that a project is complete, fully funded, and completed within the deadline.

4.2 Testing and Deployment of Smart Contracts

When building a blockchain application, a popular approach is to set up a localhost 'dummy' network. A number of test suites can set this up easily, with the most popular ones being Truffle Suite and Hardhat. Both of these frameworks can assist with compilation, deployment and testing which enables necessary functionality for building smart contracts. While we chose to use Hardhat, the choice ultimately comes down to preference. Hardhat manages a Localhost blockchain network, allowing us to rapidly deploy, test, modify, without the expenses that deploying to the Ethereum mainnet would incur.

We define a test script, which would prevent deployment if failed, however, in practice, most of the testing is done when iteratively building functionalities while interacting with the frontend.

For our deployment script, we use the javascript library Ethers, which Hardhat uses natively. During deployment, we get and print the signer, corresponding to the address of the user trying to deploy the smart contract. We then deploy the contract to the local testnet, saving the address and the application binary interface (ABI) of the contract. The ABI is a .json file containing a list of the functions, their input and output, available in our contract.

4.3 Bridging the Blockchain and the Frontend

With the ABI and the contract address, our system now has a set of instructions for how to interact with the blockchain, and by extension, our smart contract. However, this does not mean that users can now interact with our system. To make the system interactable with external users, we use an additional library, Web3.js. To make the initial connection between the contract and the frontend, we load in the ABI and the contract address. For the user to connect, they simply access the site while having a wallet extension installed. For this, we have used the most common wallet extension Metamask, while testing the functionalities of the site.

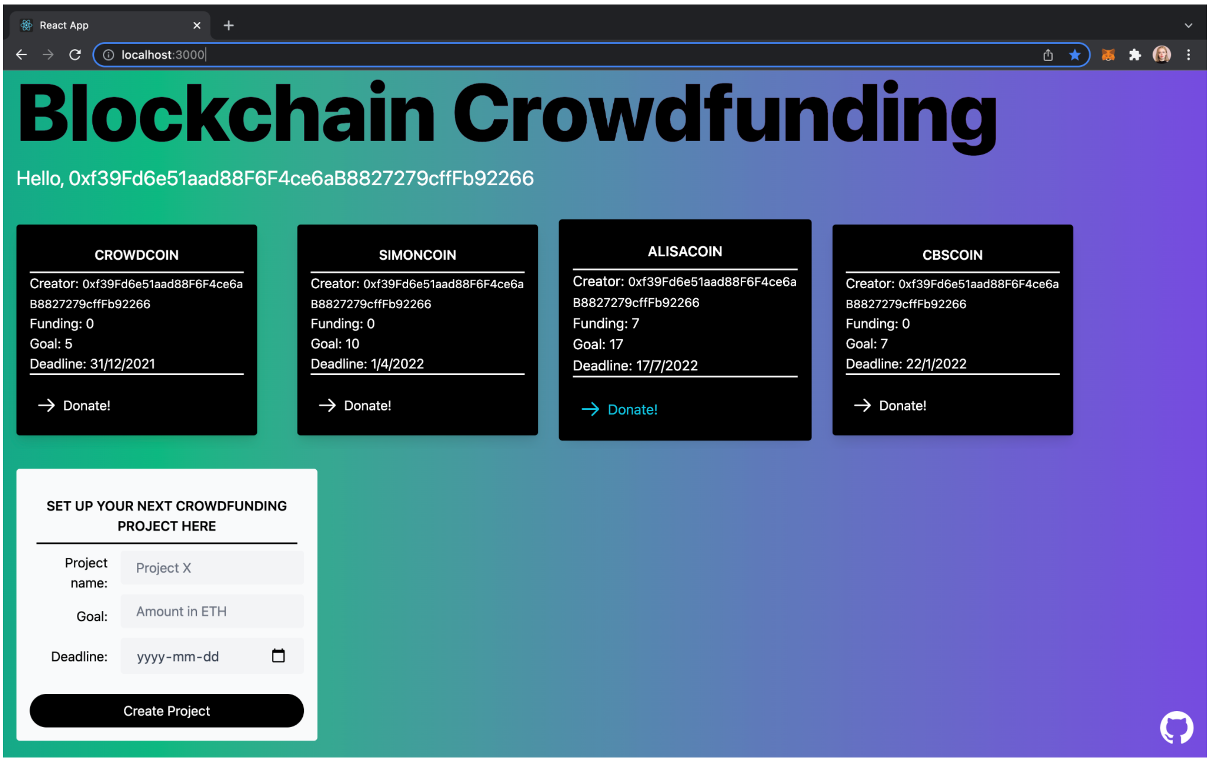

Figure 2. Frontend of the Crowdfunding Platform

To make the actual frontend, we use React to build the functionalities of the user interface and Tailwind to style them *(Figure 2)*. While the details of how we use these technologies are out of scope for this paper, we will briefly touch upon the components in the site, and how we enable them to communicate with the blockchain.

The frontend can be broken down into three primary components. The first component is simply a greeting to the user saying “Hello, {user address}”. This is both for the user to see that they have correctly connected to the site, and also to make sure they’ve connected with the correct address.

The second component is a form to create new projects. It takes three inputs, the name, funding goal and deadline of the project. Once these have been fulfilled, we are able to call the function CreateProject() defined in the smart contract through our Web3js bridge.

Finally, once at least one project has been created, we have a list of projects showing each project’s creator, current funding, funding goal and deadline. This is achieved using the aforementioned `getArr()` function. Furthermore, if a project has not yet been fully funded, then a button labelled “Donate” will also appear, allowing users to fund the project however much they want *(Figure 3)*. If a project has successfully been funded, then the button is disabled and no more funding is allowed.

Finally, on funding completion, the CCs will be able to request a payout to the address corresponding to the one that created the campaign.

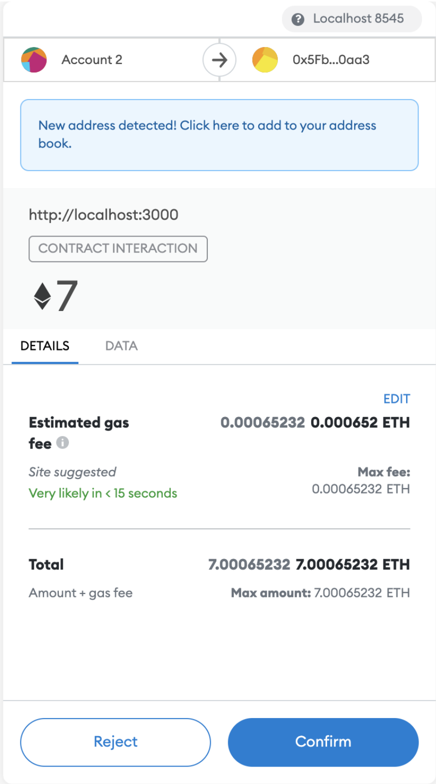

Figure 3. Confirming Donation Through Metamask

5. Discussion

The development of crowdfunding dApp offers strong potential to revolutionise the economy and provide numerous benefits to the stakeholders, impacting conventional crowdfunding. Such a dynamic is manifesting a contribution to the gap in blockchain driven crowdfunding research and is showcasing the potential for future development of decentralised fund raising. In this section, we discuss the conceptual design, how well it fulfils the requirements of a decentralized crowdfunding platform, as well as the implications of the choices made during the technical implementation.

5.1 Cost-efficiency and Transaction Costs

The distributive essence of the solution is highly cost-efficient as it avoids intermediaries thus reducing transaction costs. That, in turn, can encourage increased access to financial tools and fuel financial inclusion and the possibility of further scaling and adoption. However, the viability of small donations can be challenging as the cost of doing a transaction via Ethereum should be evaluated. As the application scales up, and the contributors might choose to donate small amounts to the project of their interest, the transaction fees through Ethereum could become an issue. Lightning network is trying to solve this issue for Bitcoin and reduce fees for small donations, raising the question of which network should be used (Investopedia, 2021).

5.2 Trust and Transparency

Developing a transparent ecosystem renders eradication of information asymmetry thus benefiting each stakeholder and ensuring authenticity. A very important topic to discuss for a blockchain based crowdfunding platform is trust. One needs to be careful with investing in ICO's, as it can be hard to calculate the actual value of the coin/token and the project and there are not many regulations on the subject yet. This means that the boundaries of creating an ICO are very limited and that increases the risk of investing in them, and as there is no regulations, they have previously been used to create fraud and scams, which is why ICO's are illegal in for instance China and South Korea, "*Because ICO's fall outside the scope of applicable law, they have often been used for scams. According to some sources, less than half of ICO's survive four months after they are offered*" (Damsgaard, J., 2021).

As these events previously have happened and people have been scammed for their money, it is hard to create trust initially with our public platform. For now, our platform has very low entry barriers based on a public blockchain, which means that anyone has access to the platform and can act as campaign creators and campaign backers. This has a benefit in creating an open platform with easy access, however, it may lower the trust from the campaign backers, as they potentially do not know if they can trust the campaign creators. Hence, the challenge of overcoming this has to be addressed, by setting up the right measures for the platform. While there is currently no single solution to this issue, a recent proposal by the World Wide Web Consortium suggests setting up a standard of decentralized identification (W3, 2021). A standard such as this could assist in projects requiring trust in other subjects.

5.3 Legal Implications

Any innovative evolving tech is challenged through the prism of legal and societal actions. Therefore, regulatory understanding is critical for further implementation of the application. Implementation of blockchain based crowdfunding decreases bureaucracy and the need for regulation yet not compromising on the legal implications in the conduct of the contract. Yet, it is crucial to evaluate how compatible blockchain and smart contracts are with the legal frameworks, and whether smart contracts are seen as legally binding in the current regulatory system (Coraggio, 2021).

5.4 Future and Potential for DAO

In the near future DAOs, decentralised autonomous organisations, can replace crowdfunding in its very foundational sense, as well as replace, in general, ordinary LLC entities (CoinDesk, 2021). DAO can trustlessly empower communities to organise and pool resources directed to a mutual goal, being also a lot cheaper and faster to set up compared to LLC. DAOs, therefore, can lead the way to the future of community and coordination. Instead of raising traditional funds, DAO can offer tokens to its contributors which would represent a certain share of value. By contributing and providing value to an organisation, creators and contributors can own DAOs together. Yet, in its current state this phenomenon lingers in the lack of clarity in terms of its legal territory. However, the scope of this subject would be beyond the topic of this project.

6. Conclusion and Future Work

Blockchain has the power to restructure the current standards of organisational and economic paradigms by creating and scaling decentralised networks. In order to explore the possibilities of combining the realms of crowdfunding and blockchain, we developed a dummy project using a local blockchain network. A variety of benefits were found in applying blockchain technologies to crowdfunding, including increased transparency and security. The seamless payment and authentication system that the Ethereum infrastructure affords with little integration costs, is rather easy to use and develop with. Despite these benefits, we identified a number of complexities that could occur, when scaling this to be a real application. With the anonymity and privacy aspect that blockchain technologies bring, the issue of trust becomes more difficult to deal with, as traditional identity verification methods become obsolete. Furthermore, we found issues in dealing with regulatory issues could become a problem as countries' govern cryptocurrencies in widely different manners.

In future work, building a platform that would be able to handle rigid technical requirements of varying projects, including and not limited to ICO's, could become challenging. Therefore, building a platform that allows a multitude of varying blockchain-related projects could require additional flexibility in the design of our smart contract. Moreover, functionality for verifying authentication of projects could be introduced. The platform could be altered to allow for more types of cryptocurrencies to be accepted. More work shall be done for enforcing regulations and developing trust in order for the dApp to mature in adoption. Finally, a number of technical details need to be fleshed out before deploying to production and releasing to a larger user base.

References

Banafa, A. (2021). How Blockchain Is Revolutionizing Crowdfunding | OpenMind. [online] OpenMind. Available at: <https://www.bbvaopenmind.com/en/economy/business/how-blockchain-is-revolutionizing-crowdfunding/> [Accessed 13 December 2021].

Chuen, D. L. K. (2018). Inclusive FinTech. In *Inclusive Fintech: Blockchain, Cryptocurrency and Ico*. WORLD SCIENTIFIC. https://doi.org/10.1142/10949

Cai, W., Wang, Z., Ernst, J. B., Hong, Z., Feng, C., & Leung, V. C. M. (2018). Decentralized Applications: The Blockchain-Empowered Software System. *IEEE Access*, *6*. https://doi.org/10.1109/ACCESS.2018.2870644

CoinDesk. (2021). *DAOs and the Next Crowdfunding Gold Rush*. [online] Available at: <https://www.coindesk.com/business/2021/12/06/daos-and-the-next-crowdfunding-gold-rush/> [Accessed 13 December 2021].

Coraggio, G. (2021). *Legal issues of blockchain and how to deal with them*. [online] Lexology. Available at: <https://www.lexology.com/library/detail.aspx?g=f47a0afa-e80f-477f-9830-a822a51df235> [Accessed 13 December 2021].

Cryptopedia. (2021). How dApps Can Revolutionize Finance. [online] Available at: <https://www.gemini.com/cryptopedia/decentralized-applications-dapps-defi-crypto#section-d-apps-are-the-building-blocks-of-the-future> [Accessed 13 December 2021].

Damsgaard, J. (2021). *Blockchain business: Ægte, sporbart og uerstatteligt.* 1. edition. Djøf Forlag.

Ethereum. (2021). Introduction to Smart Contracts. [online] Available at: <https://ethereum.org/en/developers/docs/smart-contracts/ > [Accessed 13 December 2021].

Investopedia. (2021). Can Lightning Network Solve Bitcoin's Scalability Issues?. [online] Available at: <https://www.investopedia.com/tech/bitcoin-lightning-network-problems/> [Accessed 13 December 2021].

Investopedia ICO. (2021). Initial Coin Offering (ICO). [online] Available at: <https://www.investopedia.com/terms/i/initial-coin-offering-ico.asp > [Accessed 13 December 2021].

Nast, C. (2021). WikiLeaks Wins Icelandic Court Battle Against Visa for Blocking Donations. [online] Wired. Available at: <https://www.wired.com/2012/07/wikileaks-visa-blockade/> [Accessed 13 December 2021].

Raval, S. (2016). Decentralized applications: harnessing Bitcoin's blockchain technology. In *Journal of Chemical Information and Modeling* (Vol. 53, Issue 9).

Schwienbacher, A., & Larralde, B. (2012). Crowdfunding of Small Entrepreneurial Ventures. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1699183

Startups. 2021. *Key Crowdfunding Statistics*. [online] Available at: <https://www.startups.com/library/expert-advice/key-crowdfunding-statistics> [Accessed 13 December 2021].

Szabo, N. (1994). *Smart Contracts*. [online] Fon.hum.uva.nl. Available at: <https://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html> [Accessed 13 December 2021].

W3.org. (2021). *Decentralized Identifiers (DIDs) v1.0*. [online] Available at: <https://www.w3.org/TR/did-core/> [Accessed 13 December 2021].

Yu, C., Leng, Y., Li, J., & Yu, J. (2021). Blockchain crowdfunding projects evaluation using GRA-TOPSIS. *Kybernetes*, *50*(11), 3017–3036. https://doi.org/10.1108/K-02-2020-0067

Appendix

Appendix A
https://git.io/JDB8a