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Smart Contracts to Support the Advancement of Blockchain Technology in the Security Integrity

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Abstract

The development of technology today is used as a benchmark in the advancement of the industrial world where the development of technology has influenced various aspects in the life of today's society. Smart contracts as one form of blockchain technology that resembles a conventional contract can be used to bind agreements between one party and another. One difference between a smart contract and a conventional contract is the smart contract that is stored in the blockchain. With the presence of smart contracts on the blockchain has become one of the most sought-after technologies, because the number of users is high enough for each transaction within the company. In this case various features of smart contracts applications in various worlds, ranging from financial services, life sciences, energy resources and media voting. Smart contracts still pose a lot of challenges that overwhelm the interaction of some Parties, such as users, developers, and organizations built on smart contracts. Smart contracts are essentially a very effective source of problem solvers, where smart contracts on the blockchain make it easy to maintain data security, and save costs and time. In addition, in the absence of third parties strongly minimizes the fraud that is often done by irresponsible parties, this prevents conflicts between parties. Prone to cases of loss of a document is generated because there is no secure storage media. The advent of smart contracts on the blockchain is expected to be a solution to tackle most of the world's commercial and bureaucratic systems.

Keywords*: Blockchain Technology, Smart contracts, Documents.*

1. Introduction

The rapid development of technology, making the demands of life increasingly increasing[1]. Technology plays an important role in encouraging social change, modernization and globalization. As a product of human material culture, technology contributes to the Industrial Revolution [2]. The utilization of technology in the era of digital revolution has made technology a major necessity, science and technology that develops so rapidly making technology in this era used in various fields of science [3]. The world is currently heading for the era of digitalisation and automation. This is the key to the business competition strategy, in the world of business, there is technology capable of presenting a variety of conveniences to perform various transactions and contracts. Currently, in the business belief can be realized by the existence of a contract, namely, a paper sheet that lays out the terms or conditions of the cooperation agreement between Parties [4]. By the time one of the parties violates the agreement, the path taken is the legal path. But of course the cost is not cheap and it takes a lot of time. So, taking the legal path is not profitable for the harmed Party.

Until the Smart Contract technology on this blockchain is present, Smart Contract is to apply software code executed in the Blockchain network, which aims to facilitate contracts or agreements between the parties and other Enables credible transaction performance without third parties[5]. Thus, this contract is stored in a public database and cannot be changed. By using Smart contracts, parties are able to exchange money, property, stocks or anything transparently, without conflict and without intermediaries [6]. Smart contracts are almost the same as conventional contracts i.e. document binding agreements between one party and the other, which distinguishes between Smart contracts and conventional contracts, that is[7]. a Smart Contract in the form of code that is stored in the blockchain, with the Smart contracts the parties do not need to rely on brokers, lawyers, or other intermediaries to confirm the matter, this Hall because of the absence of third parties in the Smart Contract system on the

blockchain [8]. Smart contracts also promise low transaction fees compared to conventional systems requiring trusted third parties to enforce and execute the terms of the agreement.

Figure 1. Three things in your Smart contract.

The blockchain system comes with transforming a centralistic approach to decentralization. The advantage of blockchain technology put into Smart contracts is flexibility. Developers can store virtually any type of data in the blockchain, and can have various transaction options that can be selected during the implementation of smart contracts. To run the contract, the user can only send the transaction to the contract address. This transaction will then be executed by each consensus node in the network to achieve a consensus on its output. Because Smart contracts are transparent in the blockchain, it will be distributed in the network [9]. It is going to be a lot of people to see and validate the contracts that have been made.

Smart contracts are very supported in various fields such as banking, governance, health and especially for education, the perpetrators who use the Smart Contract system on the Blockchain greatly facilitate various jobs in the bookkeeping system, Data storage, and also safeguards in data [10]. Smart contracts can be utilized for the field of education for the validation of academic credits and the issuance of academic degrees [11]. The actual digitization of this system can make safer and lower bureaucracy in terms of document validation, saving labor storage, due to the numerous counterfeiting and loss of important documents. It is very important that The process of the Smart Contract becomes more transparent and can be a reference to all parties involved. The increasingly sophisticated and growing technology has become a convenience for the community, technological opportunities must be well utilized by society [12]. Smart contracts on the Blockchain can make the world a better place with free from commissions, smart contracts as a solution that will quickly automate most of the commercial and bureaucratic systems in the world.

2. Research Method

2.1 Smart Contract Implementation Concept

The main concept behind Smart contracts uses programs to manage contractual provisions, using cryptography to ensure fraud protection, transparency, and anti-interference[13]. This digital contract automatically guarantees legality. Smart contracts should be regarded as software programs that may assume contractual properties when the parties involved decide to do so. They are a tool to enforce legality.

Having said that, a legally binding Smart contract must always meet the three elements of a conventional contract. First, a party should start an offer. Secondly, associates must agree to the terms offered. Third, the parties bargain for mutual promises and obligations. Simply put, as in conventional bidding, Smart contracts must transfer some type of value at this time or in the future. For example, one of the laws is the Uniform Electronic signature Act and Electronic Signatures in the global and National Commerce Act. This provision already acknowledges, permits, and validates the use of electronic signatures and electronic records. This involves those who use the blockchain.

Figure 2. Benefits of implementing Smart contracts.

An open-source blockchain, Ethereum executes Smart contracts. Very secure, its blockchain database, stores smart Contract transactions, including the source code. Developers use Solidity to write Ethereum smart contracts. This high-level programming language helps developers write Smart contracts that run on the Ethereum Virtual Machine (EMV) [14]. In the Ethereum database, Smart contracts exist as bytecodes. This code forms the core of Ethereum's disruptive power and innovative potential.

The Ethereum blockchain is a massive computer network that allows code to run in a decentralized, distributed way. This Blockchain does not charge. This costs for each instruction executed on the network. This Blockchain executes the generation of Smart contracts. An EMV implements an executable program on each of the Ethereum network nodes. Each system node runs the program in a synchronized way to ensure that the execution cannot be tampered with [15]. The system serves as a control to prevent exceeding network computing capacity. With the Ethereum configuration, each developer can code a simple program that can be run in a decentralized, distributed network. The network replicates its code and database storage. This process secures and tweaks the program code. The network assigns a unique address or ID as a reference to the upload code. The ID or address can trigger the contract execution at any time.

2.1 Literature Review

Blockchain technology has both decentralized consensus and algorithmic authentication and execution. The research conducted by Lin William Cong analysed the way in which decentralization increased consensus effectiveness, and the classic features of the industry organization reshaping blockchain and competition landscapes. Smart contracts can reduce information asymmetry and provide higher social welfare and consumer surplus through increased entry and competition, but blockchains can also encourage collusion due to the distribution of information not Can be reduced, especially in the consensus generation [17].

Smart contracts focus on the form of technical contracts by setting aside the social context in which contracts operate, and the complex ways in which people use them. The research explanation described by KAREN E. C. LEVY, explains the 3 categories of contract practice in which people engage to illustrate how the contract actually works [18]. Smart Contract Technology ignores the fact that people use contracts as social resources to manage their relationships. Therefore, suggesting that attention to the social and relational context of contractors is an important consideration for discussion, development, and dissemination of smart contracts.

Smart contracts can find a broad spectrum of potential application scenarios in the digital economy and the intelligent industry, including financial services, management, healthcare, and the Internet of Things, among others, and have also been integrated into the platform Mainstream blockchain-based development, such as Ethereum and Hyperledger. The research presented by Shuai Wang presents a systematic and comprehensive overview of blockchain-enabled Smart contracts, aiming to stimulate further research into this growing area of research [19]. Research conducted by S R Mani Sekhar, analyzes various use cases of Smart contracts in different domains and comes with models that can be used in the future. Furthermore, different case studies associated with five different domains are discussed with the help of use case diagrams [20].

Finally, solutions for natural disaster management have been proposed by integrating Smart contracts, digital identity, policy and blockchain technology, which can be used effectively. Blockchain Data is rarely used for process miners. The research conducted by Christopher KLINKMU ¨ller This, proposed a framework. The Framework consists of three main parts: a manifest that specifies how the data is recorded, the Extractor for the retrieving data (structured according to the XES Standard), and a generator that generates Logging code to support the developer's Smart contract, Proposes an easy way to encode Logging data in a compact form, to achieve a relatively low cost and high throughput to log-Ging on the chain. Proposals are evaluated with logs created from the generated Logging code, as well as with existing blockchain applications that do not utilize the proposed Code Generator [21].

A blockchain theory of programmatic risk chosen by the user is proposed by Melanie Swan. Black Swan Smart Contracts instantiate S-a distribution event curve so that the risk may be more efficiently managed by selecting low intermediate high risk as a standard Smart contract parameter [22]. The potential of the Black Swan Smart contracts application includes insurance as a digital service, eBay for Money, market information, and autonomous risk management as a Smart Network property.

The research conducted by Munindar P, builds decentralized applications that naturally accommodate and exploit blockchain technology. This approach avoids the shortcomings of Smart contracts that arise from their regular way of organizing computing, which restricts their prospects for practical decentralized applications. This new way of thinking allows building a flexible government, by structuring an organizational structure, verifying truth without hindering autonomy and foundation for Trust [23].

3. Listing Program

According to the discussion above this method, using the programming language solidity to verify proof of work on the Smart Contract. Solidity is a statically typed programming language designed specifically for writing Smart contracts that can run on Ethereum virtual machines[24]. It is very similar to JavaScript to make it easier to learn for Web developers.

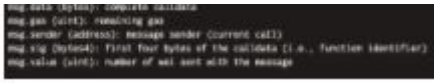
Constructor functions are only called once when a contract is created. This sets a prerequisite for Smart contracts, such as setting the number of initial tokens, etc. Every time someone sends Ethers to your Smart contracts with no additional information and without calling a certain method in the Smart contract, this method will be called. You can return funds to the sender, using the default method or distributing it as you wish.

This function is used to make transfers and collect items. Smart contracts do not need to send new transactions immediately when you press the ether into it. It can work as a database. You may see some functions have optional keywords that can be paid after the name. If you add these keywords, Smart contracts will be able to operate with Ethers. You can attach ether to a Smart Contract, send a transfer with Ethers or withdraw ethers[25]. By default, the contract does not receive money. The keywords to be paid must be added after each function that should be able to operate with money.

The second action is to save the owner. Some methods or functions may be banned for everyone except the owner. Solidity provides a nice and intelligent way to select methods that have limited permissions-we can use modifiers. TIP: Payable keyword allows delivery of these Smart contracts

Ethers[26]. If you don't add these keywords to the constructor or fallback function, you won't be able to send money to your Smart contract. However, there is a way to hack it. Two functions that work in the same way, as simple if statements that might throw an error and stop executing the code of SMART contracts[27]. The Require and Assert method does the same thing, but when you use the Assert and the condition is fulfilled, the Smart Contract will not execute, but the transaction will consume gas, that is, take some money shipper. Functions require restoring gas if Smart contracts cannot be executed.

Solidity supports multiple global variables that store information about the current transaction. They are MSG, block, and TX. The MSG object is one of the most important and useful because there we can find information about the sender, funds, or data sent to the contract. As other objects or classes in other programming languages, Smart contracts also have constructors. The contractor's name is the same as the contract name, and does not accept arguments. However, if you add payable keywords, it will accept Ethers that you can send as creators. Otherwise, the Smart Contract cannot be made with Ethers[28].



A modifier is a type of special function that can be invoked between or after other functions. Inside the modifier, use the underline function that specifies where the other method code should be laid out. In this code, it has two modifiers, namely:

```
modifier isOwner() {
  require(msg.sender == owner);
  _;
}

modifier canWithdraw() {
  require(salaryAmount[msg.sender] > 0);
  _;
}
```

A good piece of code is divided into a single responsibility component. It may have noticed that the Smart Contract, from a programmer's point of view, is very similar to classes in other languages. We can create new objects, instances of other Smart contracts[29]. The simplest use example is to create 2 Smart contracts (classes) next to each other and only create a new object inside the second one.

In this example, ContractB will create an instance of ContractA in the Public variable. ContractA is responsible for only one hall, namely: Counting add function calls. We can call this function from within ContractB. But this solution will not allow us to change the behavior of Smart contracts when

something goes wrong or when we want to change the calculations[30]. So, let's change the code in a way that will accept the instance change from Contract A.

```
contract ContractA {
  function add() public;
}

contract ContractB {
  ContractA createdContract public;
  function setContract(address contractAddress) onlyOwner public {
    createdContract = ContractA(contractAddress);
  }

  function add() {
    createdContract.add();
  }
}
```

At this point, we need to assume that the Smart Contract is similar to the same interface as Smart contract A has been deployed to the blockchain and has its own address. In this case, we will be able to pass this address to the setContract function which will create a new instance [31]. Please note the small difference that we don't use the new operator before we create a ContractA object. It is not necessary when we create an instance of the address.

4. Result and Discussion

By implementing smart contacts in everyday life, it can make phenomenal changes as it offers several advantages over conventional contracts. Smart contacts are more convenient and faster which makes it acceptable for people to streamline workflows [32]. Eliminating intermediaries makes Smart contracts, even more interesting to apply in our lives. The use of Smart contracts tends to be prepared with technological advances. From the discussion above, there are results and 8 benefits offered by Smart contracts[33].

As stated earlier, Smart contracts are full of the terms and conditions in absolute detail which are also examined by the parties involved in the agreement. This eliminates the possibility of disputes and issues at a later stage as the terms and conditions are thoroughly examined and put into place only when all participants agree to it. The nature of this smart contract enables the parties involved to ensure transparency during the transaction. In addition, the precision needed in the detailing contracts keeps all the information open with everyone who eventually solves something related to the problem of miscommunication[34].

Therefore, with the help of Smart contracts, the efficiency lost in communication gaps can be reversed. In order to continue with the process involving documentation, it usually takes more than at least a few days. Delays in this process are due to many intermediaries and unnecessary steps along the way. On the other hand, smart contracts are run through the Internet as they are nothing but a piece of software code. Therefore, the speed of completing the transaction through the smart code is too fast. Smart contracts can save hours or even days compared to any conventional business process. Additionally, the delay time due to manual involvement is also eliminated.

Smart contracts are encoded in explicitly detailed form. It requires to hold all of the terms and conditions in it before it is finally punished for work[35]. Any condition left behind from a contract can result in an error at execution, therefore while creating a Smart contract, all conditions are laid out in a detailed form. Because of this, Smart contracts become a comprehensive agreement that, when executed automatically, almost everything is done. In the case of a conventional contract, there is a possible fault as the person responsible for making the contract may lose one condition or another. Additionally, there is no way to even trace until the error is created.

Therefore, smart contracts are a better alternative when it comes to achieving accuracy and accuracy. Smart contracts with the automatic coding feature are the safest choice when it comes to encrypted data technology at this time. Because they conform to the highest safety standards, the level of protection involved therein allows them to be safe to use for critical processes. Moreover, because Smart contracts are so accurate and secure, their efficiency levels are too high which results in more value in transactions.

Smart contracts are accurate and precise for the minutest level of agreement[36]. All transaction details are kept on the contract and any person between the parties involved can access them at any given time. In addition, these transactions are stored on the blockchain in the form of future records. It is very helpful in terms of disputes regarding future contractual provisions. First and foremost, because Smart

contracts only involve the parties that are part of the agreement, the need for intermediaries is eliminated and the money involved in that is also stored. All lawyers, witnesses, and intermediaries have no role when Smart contracts are used. In addition, as stated earlier, Smart contracts also save money as paper-based documents are not involved in any process [37].

Other unique features of this contract may be their ability to significantly reduce litigation and court requirements. Executing the Smart Contract allows the parties to perform and bind by the conditions and rules written therein. Because smart contracts are computer code documents, the use of paper in the whole process is removed [38]. On the one hand, this saves costs while on the other, it's useful for companies globally because it helps to save a little bit of their paper use in terms of contracts and promotes contributions to the community. In 8 these benefits ensure that the use of Smart contracts is necessary for various aspects of the field, in addition to the absence of third parties, Smart contracts can make life more modern in the development of information technology [39].

5. Conclusion

During the course of study, all kinds of superior performance certificates, transcript scores, diplomas, etc. will be an important reference for recognizing new schools or new works. As schools make various awards or diplomas, only the school name and students are input. Because of the lack of effective anti-Forge mechanisms, events that cause the graduation certificate to be forged often get noticed[40]. In order to troubleshoot a certificate forgery, a digital certificate system based on blockchain technology will be proposed. By properties that cannot be modified from blockchain, digital certificates with anti-counterfeiting and can be made. The digital certificate issuance procedure in this system is as follows. First, generate an electronic file from a paper certificate that accompanies other related data into the database, while it calculates the electronic file for its hash value. Finally, save the hash value to the block in the system chain[41].

From this research it can be concluded, with potential Smart contracts can not be limited. Smart contracts can be used in any field, buyers and users can track anything for their security level. While for third parties such as lawyers, government agencies etc, it is only necessary to put the coin into the contract and the loss of the third role. Smart contracts save money by eliminating the need for intermediaries. When using the Smart Contract, all we need to do is check the code before execution, everything after it will be done by electronic means[42]. Smart contracts provide an opportunity to make routine transactions and processes more efficient and automated.

The basis of Smart contracts are interfaces, business rules, and data. With emerging technologies, smart contracts will also need to be updated to eliminate compatibility issues with the operating system and perform properly routed functions. Although smart contracts are still in the development phase, that may face attacks of certain vulnerabilities. In order to make Smart contracts part of everyday life, both, CyberSecurity practices as well as a platform to make Smart contracts need to be updated from time to time[43].

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References

[1] Aini, Q., Dhaniarti, I., & Khoirunisa, A. (2019). Effects of iLearning Media on Student Learning Motivation. Aptisi Transactions On Management, 3(1), 1-12. Chicago.

[2] .Rahardja, U., Aini, Q., Graha, Y. I., & Khoirunisa, A. (2019, May). Implementation of Gamification into Management of Education for Motivating Learners. In Proceeding Interuniversity Forum for Strengthening Academic Competency (Vol. 1, No. 1, pp. 209-209).

[3] Aini, Q., Alwiyah, A., & Putri, D. M. (2019). Effectiveness of Installment Payment Management Using Recurring Scheduling to Cashier Performance. Aptisi Transactions On Management, 3(1), 13-21.Chicago

[4] Mezquita, Y., Valdeolmillos, D., González-Briones, A., Prieto, J., & Corchado, J. M. (2019, July). Legal Aspects and Emerging Risks in the Use of Smart Contracts Based on Blockchain. In International Conference on Knowledge Management in Organizations (pp. 525-535). Springer, Cham.

[5] Patel, K., & Das, M. L. (2020, January). Transcript Management Using Blockchain Enabled Smart Contracts. In International Conference on Distributed Computing and Internet Technology (pp. 392-407). Springer, Cham.

[6] Shao, W., Wang, Z., Wang, X., Qiu, K., Jia, C., & Jiang, C. (2020). LSC: Online auto-update smart contracts for fortifying blockchain-based log systems. Information Sciences, 512, 506-517.

[7] Mezquita, Y., Valdeolmillos, D., González-Briones, A., Prieto, J., & Corchado, J. M. (2019, July). Legal Aspects and Emerging Risks in the Use of Smart Contracts Based on Blockchain. In International Conference on Knowledge Management in Organizations (pp. 525-535). Springer, Cham.
[8] Sultana, T., Almogren, A., Akbar, M., Zuair, M., Ullah, I., & Javaid, N. (2020). Data Sharing System Integrating Access Control Mechanism using Blockchain-Based Smart Contracts for IoT Devices. Applied Sciences, 10(2), 488.
[9] Shao, W., Wang, Z., Wang, X., Qiu, K., Jia, C., & Jiang, C. (2020). LSC: Online auto-update smart contracts for fortifying blockchain-based log systems. Information Sciences, 512, 506-517.
[10] Zupan, N., Kasinathan, P., Cuellar, J., & Sauer, M. (2020). Secure Smart Contract Generation Based on Petri Nets. In Blockchain Technology for Industry 4.0 (pp. 73-98). Springer, Singapore. Chicago
[11] Lin, J., Pipattanasomporn, M., & Rahman, S. (2019). Comparative Analysis of Blockchain-based Smart Contracts for Solar Electricity Exchanges. In 2019 IEEE Power & Energy Society Innovative Smart Grid Technologies Conference.
[12] Meneghetti, A., Parise, T., Sala, M., & Taufer, D. (2019). A survey on efficient parallelization of blockchain-based smart contracts. arXiv preprint arXiv:1904.00731.
[13] Anantha, H. R., Kulkarni, K. P., CHATURVEDI, A., Banerjee, D., & Ramakrishna, P. (2019). U.S. Patent Application No. 15/796,204.
[14] Wang, S., Huang, C., Li, J., Yuan, Y., & Wang, F. Y. (2019). Decentralized Construction of Knowledge Graphs for Deep Recommender Systems Based on Blockchain-Powered Smart Contracts. IEEE Access, 7, 136951-136961.
[15] Bhattacharya, D., Canul, M., Knight, S., Azhar, M. Q., & Malkan, R. (2019, February). Programming Smart Contracts in Ethereum Blockchain using Solidity. In Proceedings of the 50th ACM Technical Symposium on Computer Science Education (pp. 1236-1236). ACM.
[16] Tariq, F., & Colomo-Palacios, R. (2019, July). Use of Blockchain Smart Contracts in Software Engineering: A Systematic Mapping. In International Conference on Computational Science and Its Applications (pp. 327-337). Springer, Cham.
[17] Cong, L. W., & He, Z. (2019). Blockchain disruption and smart contracts. The Review of Financial Studies, 32(5), 1754-1797.
[18] Levy, K. E. (2017). Book-smart, not street-smart: blockchain-based smart contracts and the social workings of law. Engaging Science, Technology, and Society, 3, 1-15.
[19] Wang, S., Ouyang, L., Yuan, Y., Ni, X., Han, X., & Wang, F. Y. (2019). Blockchain-Enabled Smart Contracts: Architecture, Applications, and Future Trends. IEEE Transactions on Systems, Man, and Cybernetics: Systems.
[20] Chicago
[21] Sekhar, S. M., Siddesh, G. M., Kalra, S., & Anand, S. (2019). A Study of Use Cases for Smart Contracts Using Blockchain Technology. International Journal of Information Systems and Social Change (IJISSC), 10(2), 15-34.
[22] Klinkmüller, C., Ponomarev, A., Tran, A. B., Weber, I., & van der Aalst, W. (2019, September). Mining blockchain processes: Extracting process mining data from blockchain applications. In International Conference on Business Process Management (pp. 71-86). Springer, Cham.
[23] Swan, M. (2019). Blockchain Theory of Programmable Risk: Black Swan Smart Contracts. Blockchain Economics: Implications Of Distributed Ledgers-Markets, Communications Networks, And Algorithmic Reality, 1, 171.
[24] Singh, M. P., & Chopra, A. K. (2019). Computational governance and violable contracts for blockchain applications. IEEE Computer.
[25] Gatteschi, V., Lamberti, F., & Demartini, C. (2020). Blockchain Technology Use Cases. In Advanced Applications of Blockchain Technology (pp. 91-114). Springer, Singapore.
[26] Rahardja, U., Nurhaeni, T., Khoirunisa, A., & I'zzaty, R. D. (2019, December). LTAI BERBASIS TEKNOLOGI BLOCKCHAIN UNTUK MENINGKATKAN ALEXA RANK. In SENSITIf: Seminar Nasional Sistem Informasi dan Teknologi Informasi (pp. 373-380).
[27] Sato, N., Tateishi, T., & Amano, S. (2020). U.S. Patent Application No. 16/048,322.
[28] Zichichi, M., Ferretti, S., & D'Angelo, G. (2020, January). A distributed ledger based infrastructure for smart transportation system and social good. In 2020 IEEE 17th Annual Consumer Communications & Networking Conference (CCNC) (pp. 1-6). IEEE.
[29] Mandrykin, M., O'Shannessy, J., Payne, J., & Shchepetkov, I. (2020). Formal specification of a security framework for smart contracts. arXiv preprint arXiv:2001.04314.
[30] Ye, J., Ma, M., Peng, T., & Xue, Y. (2020). A Software Analysis Based Vulnerability Detection System For Smart Contracts. In Integrating Research and Practice in Software Engineering (pp. 69-81). Springer, Cham.
[31] Mandloi, J., & Bansal, P. An Empirical Review on Blockchain Smart Contracts: Application and Challenges in Implementation.
[32] Khairunnisa, R., & AL, A. M. (2020). PENGEMBANGAN DESAIN METERAI ELEKTRONIK MENDUKUNG DIGITALISASI BEA METERAI DI INDONESIA. Jurnal Komputer dan Informatika, 15(1), 288-296.

[33] SHELAR, M. K. K. (2020). USE OF BLOCKCHAIN FOR SMART CONTRCT BETWEEN TWO UNTRUSTED PARTIES WITHOUT INVLOVING A THIRD PARTY.
[34] Khatoon, A. (2020). A Blockchain-Based Smart Contract System for Healthcare Management. Electronics, 9(1), 94.
[35] Rahardja, U., Hidayanto, A. N., Hariguna, T., & Aini, Q. (2019, November). Design Framework on Tertiary Education System in Indonesia Using Blockchain Technology. In 2019 7th International Conference on Cyber and IT Service Management (CITSM) (Vol. 7, pp. 1-4). IEEE.
[36] Zheng, Z., Xie, S., Dai, H. N., Chen, W., Chen, X., Weng, J., & Imran, M. (2020). An overview on smart contracts: Challenges, advances and platforms. Future Generation Computer Systems, 105, 475-491.
[37] Zheng, Z., Xie, S., Dai, H. N., Chen, W., Chen, X., Weng, J., & Imran, M. (2020). An overview on smart contracts: Challenges, advances and platforms. Future Generation Computer Systems, 105, 475-491.
[38] Bamasag, O., Munshi, A., Alharbi, H., Aldairi, O., Altowerky, H., Alshomrani, R., & Alharbi, A. (2020). Blockchain and Smart Contract in Future Transactions—Case Studies. In Decentralised Internet of Things (pp. 169-198). Springer, Cham.
[39] Gupta, R., Tanwar, S., Al-Turjman, F., Italiya, P., Nauman, A., & Kim, S. W. (2020). Smart contract privacy protection using AI in cyber-physical systems: tools, techniques and challenges. IEEE Access, 8, 24746-24772.
[40] Mahankali, S., & Chaudhary, S. (2020). Blockchain in Education: A Comprehensive Approach–Utility, Use Cases, and Implementation in a University. In Blockchain Technology Applications in Education (pp. 267-293). IGI Global.
[41] Yusup, M., Aini, Q., Apriani, D., & Nursaputri, P. (2019, December). PEMANFAATAN TEKNOLOGI BLOCKCHAIN PADA PROGRAM SERTIFIKASI DOSEN. In SENSITIf: Seminar Nasional Sistem Informasi dan Teknologi Informasi (pp. 365-371).
[42] Patel, K., & Das, M. L. (2020, January). Transcript Management Using Blockchain Enabled Smart Contracts. In International Conference on Distributed Computing and Internet Technology (pp. 392-407). Springer, Cham.
[43] Cheng, J. C., Lee, N. Y., Chi, C., & Chen, Y. H. (2018, April). Blockchain and smart contract for digital certificate. In 2018 IEEE international conference on applied system invention (ICASI) (pp. 1046-1051). IEEE.
[44] Rahardja, U., Aini, Q., Yusup, M., & Edliyanti, A. Penerapan Teknologi Blockchain Sebagai Media Pengamanan Proses Transaksi E-Commerce. Computer Engineering, Science and System Journal, 5(1), 28-32.