A Novel Method of Secure Child Adoption Using Blockchain Technology

Chetana Pujari, Chandrakala C B, Sharadruthi Reddy Muppidi, Sanjana Reddy Yalla and Manjula C Belavagi

***Abstract*—Child adoption is a noble procedure that establishes familial bonds between a child and prospective adopters (parents). However, the adoption process can be arduous due to various challenges. Prospective adoptive parents (PAPs) seek transparency and security to ensure a fair and unbiased outcome throughout this demanding process. The Central Adoption Resource Authority (CARA) and adoption agencies also emphasize the need for accurate information in prospective parent profiles. With the world transitioning into complete digitalization, traditional adoption procedures are becoming obsolete, warranting a shift towards more advanced methods. This paper proposes the implementation of blockchain technology to address the demands of a digitalized child adoption process, providing enhanced transparency and cybersecurity. Blockchain, with its secure and decentralized database, offers a promising solution. Our approach involves the utilization of smart contracts, privacy tokens, and decentralized data storage in blocks, connected through cryptography. These smart contracts are designed based on specific adoption policies, ensuring thorough verification of prospective adopters at the outset and maintaining transparency throughout the entire process. The adoption of blockchain technology holds significant potential to revolutionize and streamline the adoption process, offering a reliable, efficient, and secure platform for the formation of precious familial relationships.**

***Index Terms*—Child Adoption, blockchain, smart contract, encryption, security.**

I. Introduction

Blockchain technology and smart contracts have emerged as transformative solutions with the potential to revolutionize various industries, including child adoption. The primary objective of our application is to leverage blockchain technology, employing smart contracts to introduce transparency and security into the child adoption process [1] and [2]. Adoption, as a legal process, entails the transfer of parental rights from biological parents to adoptive parents while preserving genetic ties to the biological family.

Manuscript received Sep 15, 2022; revised Nov 3, 2023

Chetana Pujari is Assistant Professor-Senior Scale in the Department of Information and Communication Technology, Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, Karnataka, India, 576104. e-mail:chetana.pujari@manipal.edu

Chandrakala C B is Additional Professor in the Department of Information and Communication Technology, Manipal Institute of Technology, Manipal Academy of Higher Education, Karnataka, India, 576104. (corresponding author, phone:+91 944-888-8488 e-mail:chandrakala.cb@manipal.edu)

Sharadruthi Reddy Muppidi is a student in the Department of Computer Science Engineering, Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, Karnataka, India,576104. e-mail:sharadruthi@gmail.com

Sanjana Reddy Yalla is a student in the Department of Information and Communication Technology, Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal, Karnataka, India, 576104. e-mail:sanjana.yalla@gmail.com

Manjula C Belavagi is Assistant Professor-Selection Grade in the Department of Information and Communication Technology, Manipal Institute of Technology, Manipal Academy of Higher Education, Karnataka, India, 576104. (corresponding author, phone: +91 944-862-7687 e-mail:manjula.cb@manipal.edu)

In India, the Central Adoption Resource Authority (CARA) oversees both domestic and international adoptions, prioritizing the best interests of the child and ensuring suitable placements within families. However, the adoption journey is a rigorous and multifaceted process, spanning from pre-adoption assessments to post-adoption support. CARA outlines a comprehensive set of conditions that prospective adoptive parents (PAPs) must meet to be eligible for adoption, similarly applying stringent criteria for children being considered for adoption.

The crux of our solution lies in the development of intelligent smart contracts that streamline the assessment of prospective adoptive parents, introducing accuracy and transparency to the process. By automating key components of the adoption journey through these smart contracts, we eliminate the need for intermediaries and reduce delays. This enables all participants to promptly access the outcome of their adoption status without any time-consuming hurdles.

Moreover, the smart contracts have been integrated to automate the workflow of the adoption process itself. When PAPs meet the specified conditions and eligibility criteria, the subsequent steps in the adoption process are triggered automatically, streamlining the overall procedure and expediting the placement of children with suitable families. Through this innovative use of blockchain technology and smart contracts, we aim to enhance the efficiency and fairness of child adoption, facilitating the creation of loving and stable family environments for children in need.

II. Background

A. Child Adoption Requirements

Child adoption in India falls under the purview of the Central Adoption Research Authority (CARA), allowing Indian citizens, foreign nationals, and non-resident Indians (NRIs) to adopt, regardless of gender or marital status [3]. However, to be eligible for adoption, prospective adoptive parents (PAPs) must meet specific requirements, which are outlined as follows:

- Both PAPs are required to be financially, mentally, emotionally, and physically stable, without suffering from any life-endangering illnesses.
- The combined age of a couple seeking to adopt cannot exceed 110 years, and they must have completed at least two years of marriage, as well as reaching a joint consensus on the adoption.
- Couples with more than three children are generally ineligible to adopt, except in the case of special-needs children.
- For single parents, the maximum age for adoption is 55 years. Single females can adopt a child of any gender,

while single males can adopt any child, except for a girl.
- There must be an age gap of at least 25 years between the child and the parents, although this requirement does not apply to relative or step-parent adoptions. Similarly, specific criteria must be met for a child to be considered eligible for adoption, including:
- Adoption is available for orphaned, deserted, or forfeited children who have been officially recognized as available for adoption by a child welfare committee.
- A child without a legal parent or guardian, or whose parents are incapable of caring for them, is considered an orphan.
- Children left alone or lacking parental or guardian care, and deemed abandoned by the child welfare committee, are categorized as abandoned.
- Surrendered children, who have been declared by the child welfare committee due to uncontrollable physical, social, or emotional conditions by their parents, can also be considered for adoption.
- To be eligible for adoption, a child needs to be declared "legally free."
- If an abandoned child is found, the District Child Protection Unit publishes the child's photograph and details in newspapers, and the local police are requested to trace the parents. Only after the police report stating that the parents are untraceable, the child is considered legally free for adoption.

These stringent requirements and considerations ensure that child adoption in India is conducted in a manner that prioritizes the welfare and well-being of both the prospective adoptive parents and the children in need of loving and stable families.

1) Child Adoption Process: The process of adopting a child in India is outlined below [4]. It begins with online registration on CARINGS (www.cara.nic.in), where prospective parents select an adoption agency and create a user ID and password. Valid contact details, including an email address and mobile phone number, are essential. Within 30 days of registration, parents must upload specific documents on the website. Failure to do so will necessitate re-registration. The required documents include:

- A photograph of the parent if single, or a family photo if married.
- Proof of residence, income, and one parent's PAN card.
- Birth certificate, reason for adoption, and three letters of reference from individuals.
- Marriage certificate if married, divorce decree if divorced, or death certificate of the spouse if widowed.
- A certificate from a reputable medical practitioner confirming the absence of any diseases.

Following registration, the agency must be contacted, and original documents must be presented. Any inaccuracies can render the application invalid. The Special Adoption Agency (SAA) conducts a home study within 30 days of registration to assess the parents' suitability for adoption. If deemed suitable, parents are placed on a waiting list, known as a "seniority list," where they can select one child from a preference of six children within two days.

After choosing a child, the parents can interact with the child and have a maximum of twenty days to make a final decision. Once the decision is made, documents are signed to formally accept the child. The SAA then files a petition in court, and adoptive parents sign it in the presence of a judge. Before finalizing the adoption, parents may take the child to pre-adoption foster care to better understand the child's habits and needs.

During court sessions, the judge may inquire about the investment required for the child's welfare. Adoption court orders are issued upon presenting the relevant receipt. Following the successful adoption, the agency is responsible for providing updates about the child's well-being for two years in the post-adoption phase. This comprehensive process ensures the welfare of both the prospective parents and the adopted child throughout the adoption journey.

III. Literature Review

This section explores various aspects of the child adoption process, focusing on factors influencing international parents' country selection for adoption [5], [6] and [7]. Prospective parents prioritize countries with low transactional costs, high adoption success rates, and shorter adoption processes [8]. However, the adoption system faces challenges related to excessive payments beyond the prescribed limit set by CARA [9]. Some parents are compelled to purchase life insurance policies or make donations and bribes, which make the process more expensive and raise concerns about transparency.

The COVID-19 pandemic has also impacted the adoption process negatively, resulting in longer waiting periods due to restrictions on in-person contact and court closures [10]. Amid the pandemic, there is a need for a more transparent adoption system with complete and accurate information about adoptive children [11]. Yet, some articles highlight the negative impacts of adoption on adoptive parents, such as the lack of medical records and genetic information about the child [12], [13] and [14].

The pandemic has led to the emergence of "COVID orphans," but adoption through social media requests raises concerns about child trafficking and illegal adoptions [15] [16]. The government's efforts, like the Child Adoption Resource Information and Guidance System (CARINGS), have faced challenges and discrepancies, causing delays in the adoption process [17], [18]. Uncovering cases of illegal adoptions through NGOs highlights the desperation of prospective parents to avoid long waiting times [19].

Adoption laws in India are comprehensive but often lead to lengthy and strenuous proceedings for prospective parents, necessitating transparency and accuracy [20], [21] and [22]. Budget reductions can further impede adoption agencies' work, while the lack of data and information poses challenges [23]. The time-consuming nature of the adoption process can discourage potential adoptive parents [24].

In conclusion, this literature review sheds light on the complexities, challenges, and ethical considerations involved in the child adoption process. Various factors, such as transparency, affordability, and access to information, play pivotal roles in shaping the adoption experience for both prospective parents and children. Addressing these issues is crucial for creating a more efficient, secure, and compassionate adoption system.

IV. Blockchain

A. Need of Blockchain

The key features of blockchain technology address various challenges in different domains [25]. Here are some reasons why we need blockchain:

- Security- Data stored in a blockchain is of paramount importance and often contains sensitive information. Each new block of data is sequentially and chronologically linked with older blocks, forming a continuous chain of records. The blockchain's end-to-end encryption ensures that the stored data remains tamper-proof and immutable. This inherent security feature prevents unauthorized activities or fraudulent alterations, enhancing the trustworthiness and integrity of the blockchain system.
- Transparency- Typically, organizations maintain separate databases, but blockchain operates differently by recording data in multiple locations using a distributed ledger or nodal structure. Each node possesses a copy of the blockchain, which is continuously updated with new blocks upon receiving confirmations. In the context of the Bitcoin blockchain, all transactions are openly accessible through personal nodes or blockchain explorers, enabling real-time visibility into any ongoing transactions. This transparency ensures that every Bitcoin's journey can be traced regardless of its location, making the entire process traceable and accountable.
- Traceability: By leveraging blockchain technology, users can access accurate data about the provenance of products or information. Additionally, blockchain enables the detection of flaws or gaps in traceability, which can help identify and address issues that may cause delays in the respective processes.
- Smart contract: Automation within a blockchain application is facilitated through smart contracts, which are programmable scripts executed when specific conditions are met and recorded on the blockchain. These smart contracts are designed to automate the execution of agreements, ensuring immediate conclusions without the need for human involvement, intermediaries, or delays. The workflow is also automated, triggering the next step automatically once the predetermined conditions are satisfied, streamlining the entire process.
- Efficiency and Cost Savings: Traditional paper-based procedures have become outdated and inefficient due to their susceptibility to human errors and the need for frequent third-party interventions. In contrast, blockchain technology streamlines these processes, enabling faster and more efficient operations. Vital documentation and data can be recorded on the blockchain, eliminating the need for paper-based exchanges. Furthermore, the decentralized nature of blockchain removes the need to reconcile different ledgers, resulting in significantly more efficient clearing and settlement procedures with a reduction in associated costs.

B. Role of blockchain in child adoption process

Secure sharing of data between prospective adoptive parents (PAPs) and agencies is essential for building trust and facilitating adoption decisions, contract management, identity verification, and other services [26], [27]. Blockchain technology is particularly well-suited for the child adoption process due to the following reasons:

- Decentralization: Blockchain allows data to be distributed across multiple network nodes at different locations. This decentralized nature eliminates the need for intermediaries or middlemen, minimizing the risks associated with third-party interventions. Adoption records are securely stored and cross-referenced among nodes, making it extremely difficult to tamper with the information.
- Smart Contracts: Smart contracts are programmable codes embedded within the blockchain to facilitate, verify, or enforce contract agreements. In the context of child adoption, smart contracts can be tailored to adhere to the conditions and requirements set forth by the Central Adoption Resource Authority (CARA) or other relevant authorities [28]. These contracts automatically execute the agreed-upon terms when specific conditions are met, streamlining the adoption process.

For example, smart contracts can be designed to validate and verify documents provided by prospective adoptive parents (PAPs) against the criteria specified by CARA. Once the conditions are satisfied, the smart contract triggers subsequent actions, such as issuing notifications to PAPs or updating the blockchain with the relevant adoption information. Once recorded, the data on the blockchain is immutable, ensuring the integrity and privacy of the adoption process.

By leveraging the decentralized and transparent nature of blockchain technology, the child adoption process can become more efficient, secure, and trustworthy, benefiting both prospective adoptive parents and the agencies involved.

C. A brief explanation of smart contracts specific to the child adoption process

An aspiring adopter envisions adopting a child through a smart contract with an adoption agency. The agency commits to validating the adopter's application promptly once their background aligns with the government's stipulated requirements. Both the prospective adoptive parent (PAP) and the agency have distinct roles in the smart contract agreement, ensuring a smooth process that automatically exchanges the authentication letter or notification for digitally signed documents that meet the eligibility criteria on the agreed-upon date.

Should the agency fail to provide the authentication by the specified date, the smart contract promptly raises an alert, highlighting the issue. This innovative approach eliminates the need for any fees and the involvement of illegal middlemen, third-party intermediaries, or unauthorized adoption agencies.

By leveraging the power of smart contracts and blockchain technology, this streamlined adoption process enhances transparency, trust, and efficiency while safeguarding the interests of all parties involved.

V. Proposed model

Our application utilizes the public, decentralized Ethereum blockchain, featuring smart contract functionality written in Solidity. Figure 1 illustrates the implementation of the child

adoption process through our Blockchain application. The key participants in this process are the prospective adoptive parents (PAPs) and the adoption agency.

The initial "signing up" process mandates PAPs to upload required documents as specified by the Central Adoption Resource Authority (CARA). Upon successful document uploading, the data undergoes processing through a hash function. For each document uploaded, a unique and random pattern of the same length is generated. This hash data ensures computational efficiency, regardless of the input data size.

A private key specific to each user's transaction is then generated, accessible only to the respective user. Subsequently, the authentication of documents takes place when the user signs the hash of the document information [29]. This digital signature serves as authentication for the process. When the PAP submits their transaction, they must prove their authorization over the content to every other node in the peer-to-peer (P2P) network. The P2P network verifies and checks all other nodes to reach a consensus on authentication. The process is completed only when the corresponding public key is used for authentication.

Finally, the PAP receives an online acknowledgment, and their data is updated on the blockchain ledger in the form of a new data block [30]. These blocks are added to the blockchain ledger following the Ethereum protocol, generating the cryptocurrency Ether (ETH) in the process. The sequence diagram, as shown in Figure 2, provides a chronological representation of the entire adoption process, illustrating the interactions and messages involved. The diagram features prospective adoptive parents (PAPs) as the main actors and includes objects such as the website, web back-end, and adoption agency. The adoption process commences with the PAPs registering online on the website. Subsequently, the web back-end verifies the provided details and based on their authenticity, displays a message to the PAPs. If the credentials are valid, the PAPs receive an online acknowledgment; otherwise, a message indicating invalid details is shown.

Following the initial registration, the PAPs submit all the necessary documents as specified by the adoption agency. The web back-end then verifies the submitted documents using smart contracts. If the documents are found to be inaccurate, the website displays a message stating that the application is invalid for the PAPs. Conversely, if the submitted information is accurate, the website displays a message confirming the validity of the application.

Finally, the PAPs submit the original documents to the adoption agency, which then communicates the validation of the documents back to the prospective parents. The sequence diagram effectively illustrates the step-by-step flow of interactions in the adoption process. Figure 3 represents the blockchain database graph, showcasing the structure and relationships between nodes that form the database schema. On the other hand, Figure 4 displays the scrollable user interface (UI) page of the application. The UI starts with fields for entering name and email, where valid information must be provided. Following that, the marital status field presents four options: single, married, divorced, and widowed. Subsequent fields include a family photo, proof of residence, proof of income from the last year, birth certificate, one parent's PAN card, marriage certificate or divorce decree, medical practitioner's report, and three letters of recommendation, all requiring document uploads.

TABLE I: Software Tools Used

Software	Version
Node.js	v14.15.4
Solidity	v0.5.16
Ganache	v2.5.4
Metamask	v10.18.3
Remix IDE	v0.11.0
Web3	v1.3.5
Processor	Intel(R) Core(TM) i5-5200U CPU @ 2.20GHz 2.19 GHz
RAM	16.0 GB
OS	Windows 10 Pro 21H2

TABLE II: Software Tools Description

Software	Description
Node.js	Real-time apps can be created using the open source Node.js (Node) server-side execution framework for JavaScript programming.
Solidity	For the purpose of building smart contracts on several blockchain systems, most notably Ethereum. Solidity is an object-oriented programming language which is used.
Ganache	A personal Ethereum blockchain is set up using Ganache to deploy contracts, develop applications, and run tests, giving the ability to perform all actions on the main chain without cost.
Metamask	Metamask is a web wallet that allows transactions for accessing Ethereum-based distributed applications, or Dapps.
Remix IDE	Remix IDE() is an open-source web application that facilitates the entire process of contract creation with Solidity and Ethereum.

Table I lists the software tools used along with the versions used. The smart contracts are implemented using Solidity, an object-oriented programming language. These contracts were deployed using Remix IDE (Integrated Development Environment), as depicted in Figure 5. The execution of smart contract code occurs within the Ethereum Virtual Machine (EVM), where it is compiled into low-level bytecode by a Solidity compiler. During this stage, function calls and variable assignments are also debugged. To facilitate interaction with the Ethereum blockchain, Metamask, an Ethereum wallet, injects the web3.js JavaScript library into the user's web browser. Metamask ensures privacy, security, and anonymity by not storing user data and allows seamless integration with various browsers of choice.

For smart contract deployment and testing, Ganache provides an in-memory blockchain that mimics an Ethereum node. It serves as an ideal environment to deploy and interact with smart contracts. By linking the RPC address of Ganache to Metamask and importing the corresponding private key, a new account is created and connected to Remix IDE. Once the smart contract is deployed on Remix IDE, gas or Ether (ETH) is utilized from Metamask to execute the transaction, resulting in a successful deployment. For document digital signatures, hashing is used to sign and verify the documents, as illustrated in the code snippet shown in Figure 6.

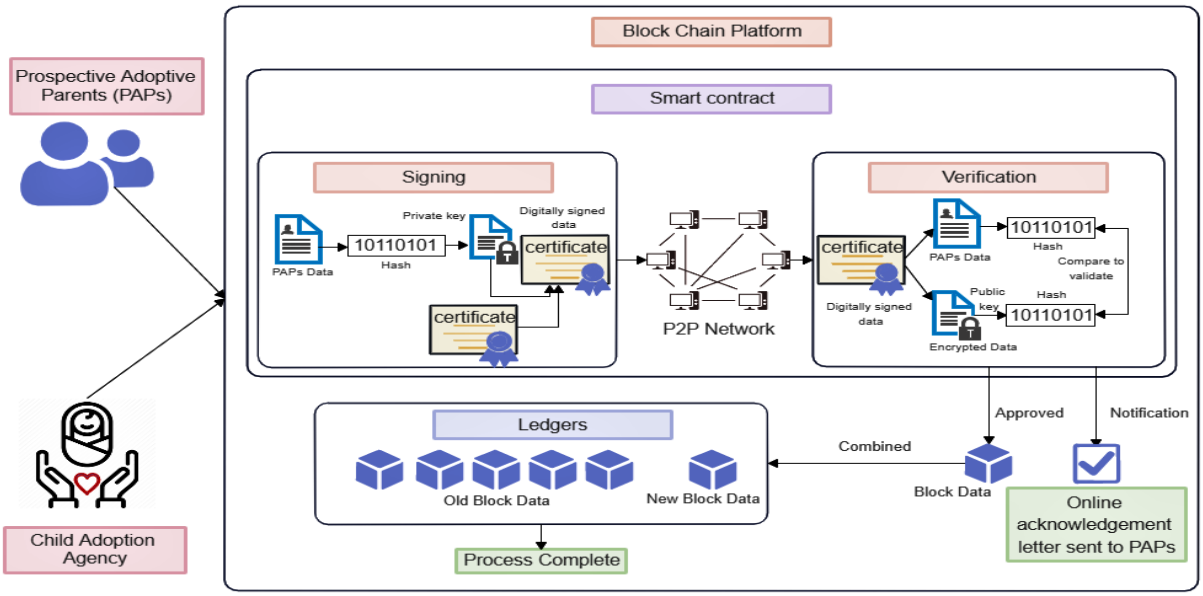

Fig. 1: Architecture diagram

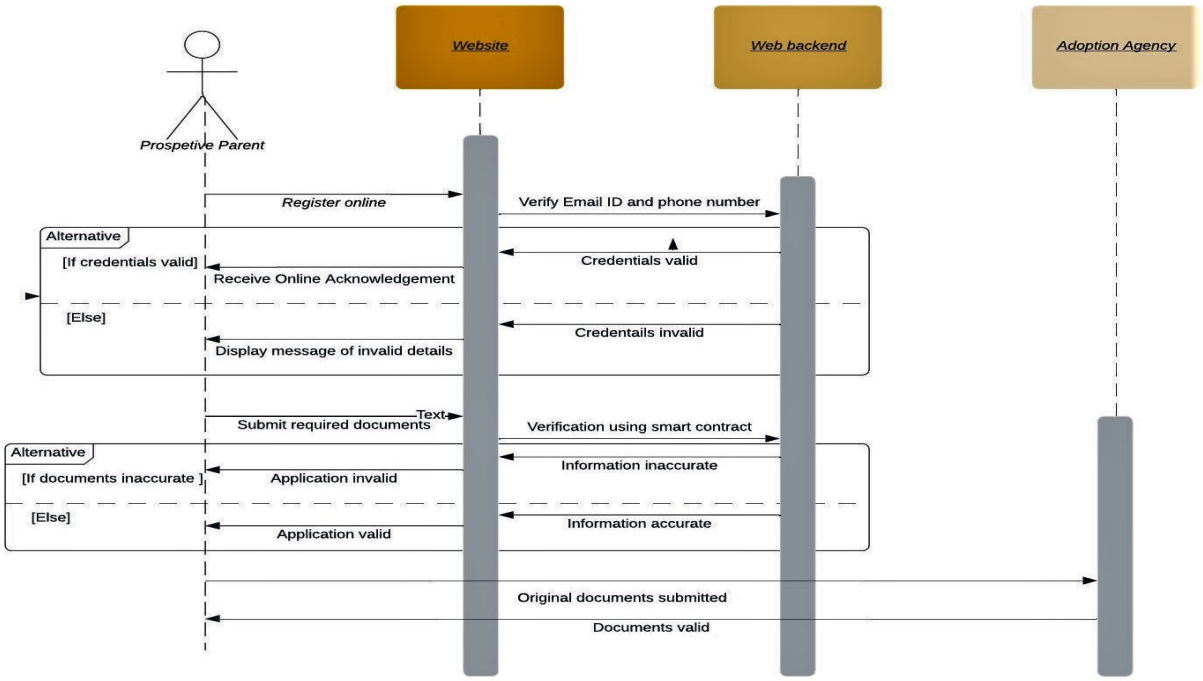

Fig. 2: Sequence diagram

VI. Results

Our work addresses several inherent issues within the current adoption system, providing effective solutions. One of the major drawbacks was the lack of transparency, which has been overcome through our new system. The adoption agency's proceedings and children's data are constantly accessible to parents as they are stored on the Interplanetary File System (IPFS), ensuring complete transparency and minimizing malpractices. Both prospective adoptive parents (PAPs) and children benefit from the new system. PAPs' information is saved on the decentralized blockchain, providing children with comprehensive knowledge about their potential parents, making the entire process credible and the verification process error-free. The use of smart contracts enables automated verification based on predetermined conditions, ensuring children find suitable parents through a faultless process. The digitization of the adoption process addresses the complexity and lengthy waiting periods that discourage PAPs from adopting. With digital document verification and automated processes, the entire adoption process becomes more efficient, taking around 2–3 months from registration to completion.

To address payment-related issues involving middlemen, our application requires a preliminary registration fee to be paid by PAPs during registration. All involved parties' fees are recorded and predetermined in the code, preventing unauthorized charges and ensuring transparency. The new online adoption system provides adoption agencies with a suitable budget, and the transactional costs are as specified

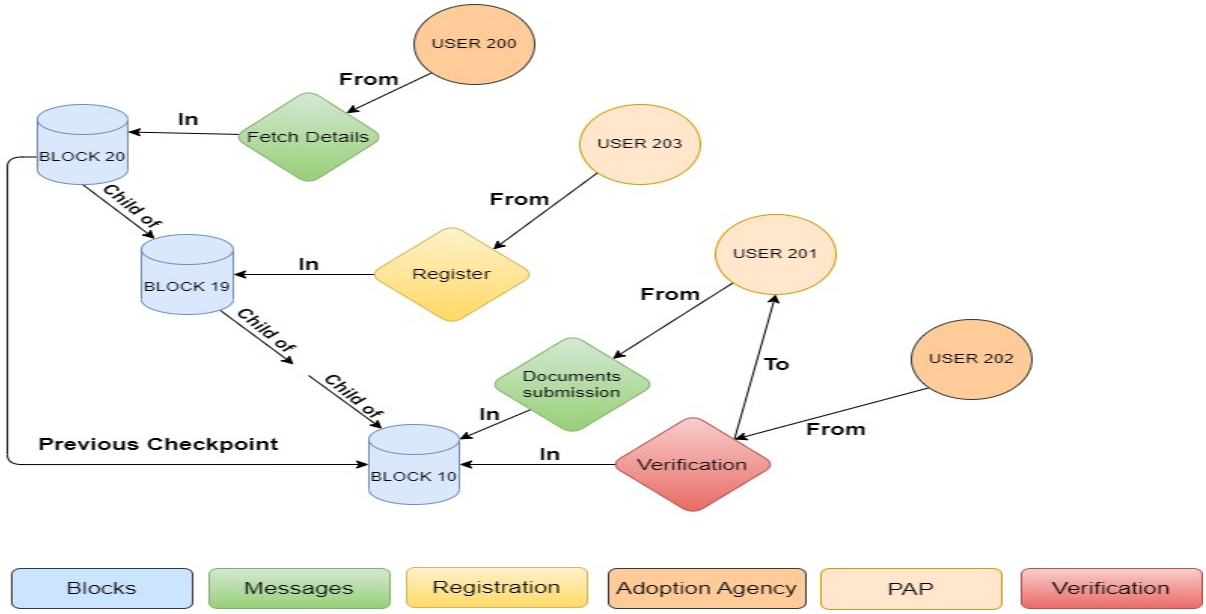

Fig. 3: Blockchain Database Graph Model

by the government, avoiding excessive fees. International adopters can view the costs and make informed decisions. During the COVID-19 pandemic, the adoption process faced challenges, leading to the abandonment of many "COVID orphans." Our application offers a potential solution by registering these children in the database, and efficiently connecting them with verified prospective parents seeking to adopt.

Overall, our work significantly improves the adoption process, enhancing transparency, efficiency, and the overall adoption experience for both parents and children.

TABLE III: Comparison between current CAS and proposed CAS

Features	Proposed CAS	Current CAS
Ease of Use	yes	no
Confidentiality	yes	yes
Transparency	yes	no
Immutability	yes	no
Encryption	yes	no
Easy availability	yes	no
Need for payment	no	yes

A. *Performance Analysis and Results*

Figure 7 displays the graph illustrating the total gas usage per transaction (in ETH or Ethereum bucks), while Figure 8 represents the response time (in seconds) graph. Both graphs consist of 10 instances, each corresponding to a different testing scenario with unique inputs, varying numbers of entries in the blockchain ledger, and different numbers of nodes. Furthermore, Figure 9 visually portrays the sum of time taken for smart contract execution and digital signature verification. This graph provides insights into the combined processing time for these essential tasks. Lastly, Figure 10 exhibits distinct execution times for three different blockchain operations: add, update, and fetch records. Each value on the graph corresponds to a specific blockchain entry, enabling a comprehensive comparison of the execution times for various operations.

VII. Security Analysis

In this section, we highlight the security attacks that our proposed work can overcome. The following potential attacks have been mitigated by our solution:

1) Data Tampering: The use of blockchain technology ensures that the adoption records are tamper-resistant. Once data is added to the blockchain, it becomes immutable and cannot be altered, making it highly secure against data tampering attacks.
2) Unauthorized Access: Ethereum blockchain employs cryptographic keys for user authentication and access control. Smart contracts enforce permissions, allowing only authorized users (prospective adoptive parents, adoption agencies) to interact with the system, mitigating unauthorized access attempts.
3) Fraud and Misrepresentation: With the transparency and traceability of blockchain, it becomes difficult for malicious actors to engage in fraudulent activities or misrepresent information in the adoption process.
4) Middleman Interference: The use of smart contracts eliminates the need for middlemen or intermediaries in the adoption process.
5) Sybil Attacks: Ethereum blockchain's Proof-of-Work (PoW) or Proof-of-Stake (PoS) consensus mechanisms make it difficult for attackers to perform Sybil attacks.
6) Man-in-the-Middle Attacks: The use of cryptographic keys and digital signatures in Ethereum transactions provides protection against man-in-the-middle attacks.

VIII. Conclusion

Our application aims to improve the child adoption process by addressing the complexities and lack of transparency that have hindered the journey for many prospective parents. In the adoption process, we ensure transparency and authenticity by using blockchains and smart contracts. Through

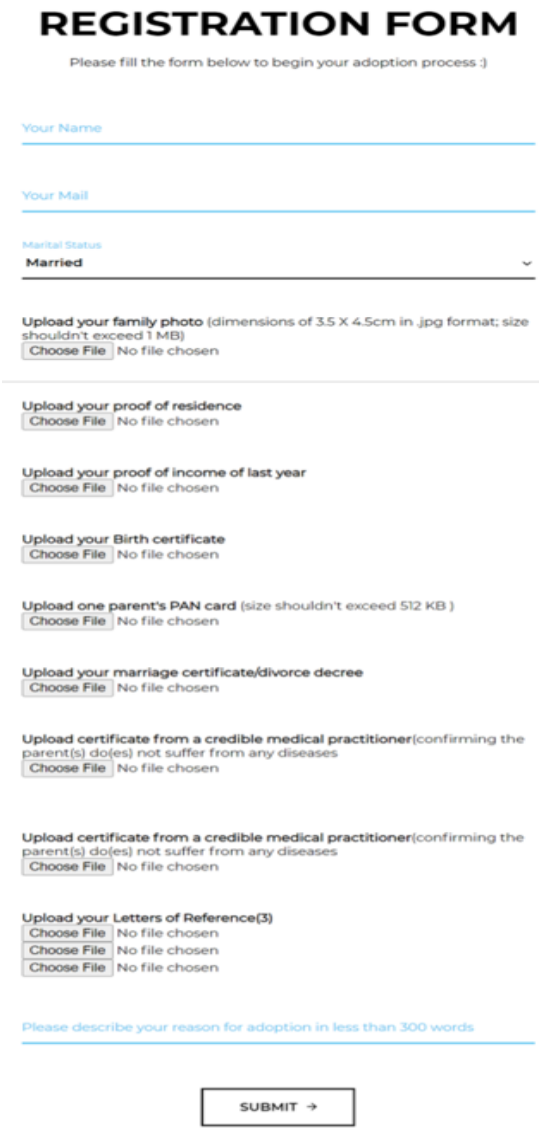

Fig. 4: User Interface (UI) - Home page

```
contract Adoption {
    // Model Candidate
    struct Adopter {
        uint id;
        string name;
        string mail;
        string
        marital;
        string desc;
    }
     mapping(uint=>Adopter) public adopters;
      uint public count=0;

    constructor() public {
        createAdopter(           );

    }
     event submittedEvent(
       uint indexed count
    );
    function createAdopter(string memory _name,
    string memory _mail, string memory _marital,
    string memory _desc) public {
    count++;
    adopters[count]=Adopter(count,_name,_mail,_marital,
    _desc);

    emit submittedEvent(count);
  } }
```

Fig. 5: Code snippet of Smart Contract

```
//Hash algo to find the signature
const hashAlgorithmOid = forge.asnl.derToOid(digestAlgorithm);
const hashAlgorithm = forge.pki.oids[hashAlgorithmOid].toUpperCase();

//Verifier creation
const buf = Buffer.from(forge.asnl.toDer(set).data,"binary");
const verifier = crypto.createVerify(`RSA-${hashAlgorithm}`);
verifier.update(buf);

//Verification
const cert = forge.pki.certificateToPem(meessage.certificates[0]);
const validAuthenticatedAttributes = verifier.verify(cert, sig, "binary");
if (!validAuthenticatedAttributes)
  throw new Error("Wrong authenticated attributes");

//Creation of hash of non signature part of PDF const
pdfHash = crypto.createHash(hashAlgorithm);
const data = extractedData.signedData;
pdfHash.update(data);

//Extraction of the message digest
const oids = forge.pki.oids;
const fullAttrDigest = attrs.find(
  (attr) => forge.asnl.derToOid(attr.value[0].value) === oids.messageDigest
);
const attrDigest = fullAttrDigest.value[1].value[0].value;
```

Fig. 6: Code snippet of Hash algorithm used

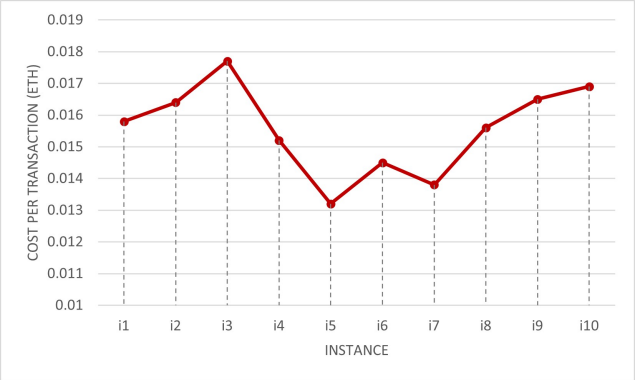

Fig. 7: Total Gas Usage

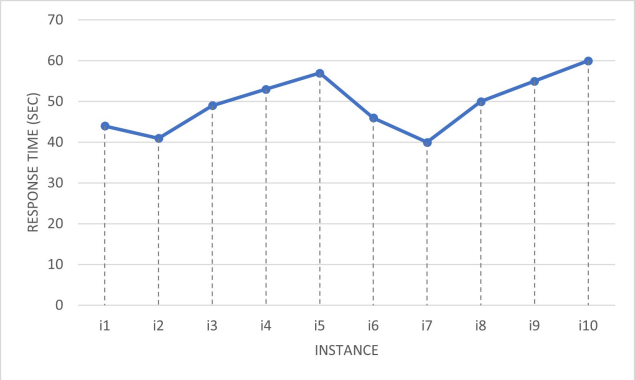

Fig. 8: Response time

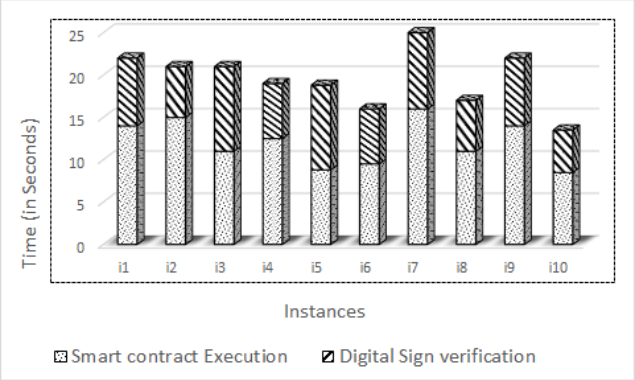

Fig. 9: Execution time for Smart contract and digital sign verification

blockchain-based smart contracts, we provide adopters with a clear view of the eligibility criteria, making it easier for them to fulfill the requirements. As part of the security protocol, the adopter's data is encrypted and safeguarded, ensuring their privacy and security. Furthermore, smart contracts automate the authentication of submitted documents, reducing delays and streamlining the verification process. Overall, our application successfully gets around the challenges that are now present, streamlining the adoption process and matching prospective parents with kids who need a loving home. We work to make the adoption process satisfying and beneficial for all parties by attaining transparency, security, and authentication.

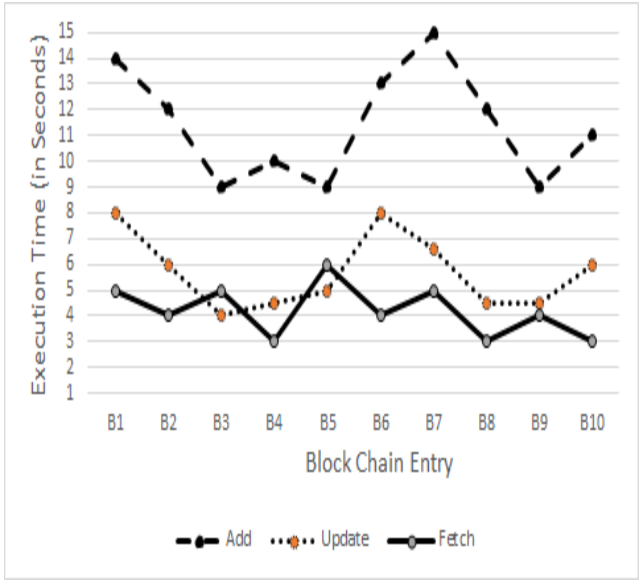

Fig. 10: Execution Time for different blockchain operations

APPENDIX A

S. No.	Abbreviation	Description
1	CARA	Central Adoption Resource Authority
2	PAP	Prospective Adoptive Parent
3	CAS	Child Adoption System
4	NRI	Non Resident Indian
5	DCPU	District Child Protection Unit
5	SAA	Special Adoption Agency
7	CARINGS	Child Adoption Resource Information and Guidance System
8	NGO	Non-Governmental Organization
9	IDE	Integrated Development Environment
10	EVM	Ethereum Virtual Machine
11	RPC	Remote Procedure Call
12	ETH	Ether
13	IPFS	InterPlanetary File System

REFERENCES

[1] Razali, N. A. M., Wan Muhamad, W. N., Ishak, K. K., Saad, N. J. A. M., Wook, M., & Ramli, S. "Secure Blockchain-Based Data-Sharing Model and Adoption among Intelligence Communities". IAENG International Journal of Computer Science, vol. 48, no.1, pp. 18-31, 2021.

[2] Rghioui, Anass, Said Bouchkaren, and Anas Khannous. "Blockchain-based Electronic Healthcare Information System Optimized for Developing Countries". IAENG International Journal of Computer Science Vol 49, no. 3, pp 833-847, 2022.

[3] Mahak Arora. Child Adoption in India: Rules, Process and Laws.https://parenting.firstcry.com/articles/a-complete-guide-to-child-adoption-in-india/. Accessed 03 March 2022.

[4] "Overview of Child Adoption Process in India". https://vikaspedia.in/social-welfare/women-and-child-development/child-development-1/child-adoption/overview-of-child-adoption-process-in-india. Accessed 07 March 2022.

[5] Efrat, Asif, David Leblang, Steven Liao, and Sonal S. Pandya. "Babies across borders: The political economy of international child adoption." International Studies Quarterly vol. 59, no. 3, 2015, pp 615-628.

[6] Léveillé, S., & Chamberland, C. "Toward a general model for child welfare and protection services: A meta-evaluation of international experiences regarding the adoption of the Framework for the Assessment of Children in Need and Their Families (FACNF)". Children and Youth Services Review, vol. 32, no.7, pp 929–944, 2010. https://doi.org/10.1016/j.childyouth.2010.03.009

[7] Palacios, J., Adroher, S., Brodzinsky, D. M., Grotevant, H. D., Johnson, D. E., Juffer, F., Martínez-Mora, L., Muhamedrahimov, R. J., Selwyn, J., Simmonds, J., & Tarren-Sweeney, M. "Adoption in the service of child protection: An international interdisciplinary perspective". Psychology, Public Policy, and Law, vol.25, no.2, pp 57–72, 2019. https://doi.org/10.1037/law0000192

[8] Palacios, J., & Brodzinsky, D. "Review: Adoption research: Trends, topics, outcomes". International Journal of Behavioral Development, vol. 34, no. 3, pp 270–284, 2010. https://doi.org/10.1177/0165025410362837

[9] Aarefa Johari. "Why some parents are paying more than the official fee to adopt a child". https://scroll.in/article/743276/why-some-parents-are-paying-more-than-the-official-fee-to-adopt-a-child. Accessed 17 March 2022.

[10] Rupsa Chakraborty. "The wait to adopt a child got longer amid pandemic". https://www.hindustantimes.com/cities/others/the-wait-to-adopt-a-child-got-longer-amid-pandemic-101613936178297.html. Accessed 01 April 2022.

[11] Parul Malik. "Child adoption process needs to be transparent". https://www.againstchildtrafficking.org/2007/10/child-adoption-process- needs-to-be-transparent/. Accessed 04 April 2022.

[12] "Long-term effects of adoption". https://consideringadoption.com/adopted/impact-of-adoption/long-term-effects-of-adoption/. Accessed 10 April 2022.

[13] "Child Welfare Information Gateway". https://www.childwelfare.gov/topics/adoption/intro/. Accessed 16 March 2022.

[14] Norah M. Alwash, Vincent J. Palusci, "Factors related to medical neglect recurrence and foster care and adoption services, Child Abuse & Neglect", vol. 123, no. 1, pp 105378, 2022. https://doi.org/10.1016/j.chiabu.2021.105378.

[15] Okoli, R. C. B., & Udechukwu, N. S. (2019). "Child adoption, child trafficking and illegal surrogate parenting practices in Nigeria: The need for social work intervention". Journal of Social Work in Developing Societies, vol.1, no.1, pp 46-60, 2019. Retrieved from https://journals.aphriapub.com/index.php/JSWDS/article/view/664

[16] Sara Bardhan and Neymat Chadha. "The Challenges and Unaddressed Issues of Child Adoption Practices in India". https://thewire.in/soceity/challenges-issues-child-adoption-practices-india. Accessed 17 April 2022.

[17] "Child Adoption Resource Information and Guidance System (CARINGS) 3.2". https://carings.nic.in/Parents/Guidelines-for-Adoption.aspx. Accessed 12 March 2022.

[18] Ambika Pandit. 36,000 couples in queue, but CARA has 1936 kids: Report. https://timesofindia.indiatimes.com/india/36000-couples-in-queue-but-cara-has-1936-kids-report/articleshow/88625272.cms. Accessed 15 April 2022.

[19] Shobana Radhakrishnan. "Long-waiting period, social stigma force couples into illegal adoption: Expert". https://www.newindianexpress.com/states/tamil-nadu/2021/jul/11/long-waiting-period-social-stigma-force-couples-into-illegal-adoption-expert-2328442.html. Accessed 20 April 2022.

[20] "Legal Service India - Lawyers" https://www.legalserviceindia.com/legal/article-5828-adoption-issues-and-challenges.html. Accessed 21 April 2022.

[21] M.V. Kartik, Mr. Dhanasekar, "Child Adoption in India- Issues and Challenges". 2018.

[22] Riya and Neelaksh , "Comprehensive Study on Child Adoption in India with Special Reference to Hindu Laws", International Journal of Law Management & Humanities, vol. 4, no. 3, pp 1493 - 1503, 2021, DOI: https://doij.org/10.10000/IJLMH.11616

[23] Saras Bhaskar, Rene Hoksbergen, Anneloes van Baar, Subasini Mothiram and Jan ter Laak, "Adoption in India- the past, present and the future trends". International Journal of Research and Analytical Reviews, vol. 6, no. 2, 2019.

[24] Akshita Prasad, Kunal Nema, "Child Adoption in India: A Comprehensive Study". International Journal of Legal Developments and Allied Issues, vol. 5, no.5, pp 1-13, 2019.

[25] "What is blockchain technology?" https://www.ibm.com/topics/what-is-blockchain. Accessed 15 March 2022.

[26] Xu, M., Chen, X. Kou, G. "A systematic review of blockchain". Financial Innovation vol. 5, no.27 , 2019. https://doi.org/10.1186/s40854-019-0147-z

[27] Yuan, Ke, Yingjie Yan, Lin Shen, Qian Tang, and Chunfu Jia. "Blockchain Security Research Progress and Hotspots". IAENG International Journal of Computer Science vol. 49, no. 2, pp 433-444, 2022.

[28] Aarefa Johari. "Adoption in India is a challenge. The pandemic made it a nightmare". https://scroll.in/article/973092/adoption-%20in-india-is-a-challenge-the-pandemic-made-it-a-nightmare. Accessed 17 April 2022.

[29] Ryusei Fuji, Shotaro Usuzaki, Kentaro Aburada, Hisaaki Yamaba, Tetsuro Katayama, Mirang Park, Norio Shiratori and Naonobu Okazaki "Investigation on Sharing Signatures of Suspected Malware Files Using Blockchain Technology". Proceedings of the International MultiConference of Engineers and Computer Scientists , March 13-15, 2019, Hong Kong, pp 94-99.

[30] Chinazaekpere Ngubo, Mischa Dohler, and Peter Mcburney. Blockchain, IoT and Sidechains. Proceedings of the International MultiConference of Engineers and Computer Scientists , March 13-15, 2019, Hong Kong, pp 136-140.

[31] Noor Afiza Mat Razali, Wan Nurhidayat Wan Muhamad, Khairul Khalil Ishak, Nurjannatul Jannah Aqilah M. Saad, Muslihah Wook, and Suzaimah Ramli. "Secure Blockchain-Based Data-Sharing Model and Adoption among Intelligence Communities".International Journal of Computer Science, vol. 48, no. 1, pp 18-31, 2021.

[32] Sirapat Boonkrong. "Security Analysis and Improvement of a Multi-Factor Biometric-Based Remote Authentication Scheme". IAENG International Journal of Computer Science, vol. 46, no. 4, pp 713-724, 2019.