

BUILDING TRANSPARENT PROFESSIONAL REPUTATION: A BLOCKCHAIN FRAMEWORK A TRUSTWORTHY BADGE BASED IDENTITY SYSTEM

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Abstract

In today's advanced digital world, it is very important to construct a professional reputation on which people can trust. This paper will recommend a badge identification system which is based on Blockchain that gives clear-cut, unbreakable proof of credentials and professional achievements. In this proposed approach, it will incorporate Smart Contracts and Decentralized Identifiers (DIDs) to provide trust, scalability, and privacy to the people. A Blockchain with limited access will be established so that companies can issue and give authentic digital badges which is suitable for reputation verification, and use some security analysis to evaluate the system. The results show that badge systems that are using blockchain are more safe and scalable alternative to traditional ways of checking credentials.

This study represents a blockchain-based system for badge-driven identity and reputation management which is used for Verifiable Credentials (VCs), Smart Contracts and decentralized identifiers (DIDs) to get rid of the problems which are faced in traditional way. In this suggested system, recognized institutions may provide professionals credentials that are temper-proof and can be verified by cryptography. These credentials may be used as proof of affiliation. These badges are linked with the self-governing identities, so that users can be sure about their work.

A reputation score model will be constructed by putting together endorsement graphs, badge information, and issuer credibility that will see how trustworthy a professional is working. The system uses Ethereum smart contracts, open-source DID protocols to create the identification without central authority, and IPFS which will store badges off-chain.

The research will contribute to the domains of decentralized identity management, blockchain applications in a trusted system, and algorithmic reputation modeling in both theory and practice. The suggested system will make the possibility to check and transfer professional credentials, that will open up new possibilities for education, job verification, freelancing platforms, and decentralized learning ecosystems. At the end, it gets closer to the aim of a digital reputation system that users can manage and trust, which is important for the new Web3 and knowledge economy.

INTRODUCTION

In today's world of technology Professionals in many fields are finding that having verifiable credentials and a good reputation are becoming more and more crucial. More and more people are using digital credentials to generate trust. For example, academics post their work on open repositories, while freelancers show off their skills on platforms like Upwork. The current reputation systems are centralized, which are making individuals to trust less on the organizations. Systems that are working for professional reputation are becoming more and more significant in today's

digital economy. These methods are considered to be a better way to evaluate someone's talents, credentials, and achievements. But there are a number of problems with the old techniques for validating and keeping professional credentials, such the chance of fraud, a lack of openness and long verification times. Digital badge systems are an innovative approach to acknowledge talents, achievements, and connections that can be carried out. Standards like the Mozilla Open Badge framework which let organizations to give out credentials with information that users may view

on multiple devices. Even badge systems might be valuable, they are simple to hack and they don't have good techniques to validate their correctness.

There are many different ways to use blockchain technology. Because it is open, decentralized, and hard to modify. When Smart Contracts are used, it helps to create programmable trust frameworks that will allow algorithms to issue, verify, and approve badges without any centralized authority. Blockchain technology is able to fix the challenges that professional reputation systems are facing nowadays. The technology is secure and straightforward way to handle and verify credentials as it is decentralized and can't be changed. W3C's proposed Decentralized Identifiers (DIDs) and Verifiable Credentials (VCs) also provide a framework

which helps in identifying people that protects their privacy and gives them full control over their identity. The main goal of this project is to create a blockchain-based framework that uses decentralized identity protocols, smart contracts, and digital badges for making verifiable badge identities to make improved Professional Reputation systems. The technology allows trustworthy groups to give out these cryptographically authenticated badges, which professionals can carry and exhibit with them to prospective employers, partners, or online communities. A model will also be created for calculating reputation that leverages badge accumulation and endorsement networks that will show how trustworthy someone is clear.

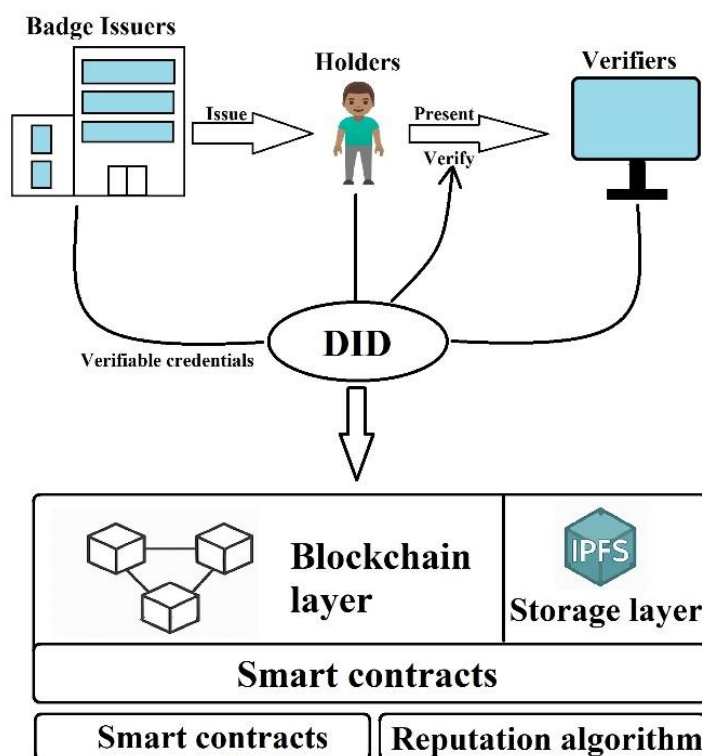


Figure 01: System Architecture

The Problem Statement

To develop a reliable and verifiable reputations system is still a significant challenge in the growing digitalization of professional ecosystems. LinkedIn, Coursera, Upwork and academic repositories are used as traditional reputation systems, these are centralized and incompatible because of its limited sincerity and durability.

Moreover, they commonly lack for external verification procedures and do not provide any authority to the users over their own data, which results in a number of problems, it can include badge inflation, or data fabrication, or unverifiable credentials.

Although digital badges have become widespread signs of accomplishment and talent, current implementations frequently lack cryptographic assurances of integrity and validity. Furthermore, there is no clear or consistent way to confirm who issued a badge, if it has been withdrawn or how it gradually enhances a person's credibility in the workplace. This diminishes trust in badge-based identity systems and limits their use in high-stakes settings like peer to peer markets, academic certification and employment.

Many of these issues can be resolved by the promising primitives provided by Blockchain technology, which is including immutability, decentralized consensus, smart contracts and verifiable credentials. However, there isn't yet a standardized framework for combining blockchain technology with badge-based identity systems to facilitate the development of transparent and private professional reputations.

Moreover, the advantage of using decentralized are diminished by present blockchain identification models, which frequently ignore precise reputation scoring a high level of faith in centralized oracles.

The MAIN problem is

How can we create and use blockchain-based badge identification framework that allows for the decentralized and transparent development of professional reputation while maintaining privacy and verifiability to fraud?"

A multidisciplinary strategy encompassing blockchain protocol design, decentralized identity management, verified credentials and safe smart contract engineering is needed to address this issue.

Aim and Objectives

Aim:

The main aim of this research is to Designing, Implementing and assessing a blockchain-based badge identity framework that supports translucent safe and reliable professional reputation systems. The proposed

architecture will make use of decentralized technologies which are including smart contracts, decentralized identifiers (DIDs) and verifiable credentials (VCs) to enable temper-resistant badge issuance and decentralized reputation computation.

Objectives

- Evaluate the drawbacks of currently centralized and badge based professional reputation systems, taking the concerns about decentralization, data control, tempering authentication and confidentiality.
- Using blockchain smart contracts and decentralized identity concepts, develop a decentralized badge issuance and verification system that will allow organizations to provide cryptographically secure and verifiable credentials.
- To provide for user-controlled, privacy-preserving reputation management by including Decentralized Identifiers (DIDs) and Verifiable credentials (VCs) into the identity system.
- Build an advanced reputation scoring system that integrates badge metadata, issuer credibility to measure an individual's credibility in a verifiable and decentralized way.
- Investigate the performance of the system in terms of verification, adaptability and user-sovereign on artificial and real world cases.

Scope/Significance of the study

The scope of this research is focused on the feasibility of technology and real-world applicability within the digital credentialing systems, while acknowledging the boundaries of the legal, economic and global deployment factors. The research is focused on the design, implementation and evaluation of the blockchain badge-based identity and reputation framework that aimed to create transparent, verifiable and Decentralized professional reputations.

The study will cover following points:

- Design for a Decentralized architecture which will include badge issuance, verification and endorsement by using Smart Contracts.
- the integration of decentralized Identifiers (DIDs) and Verifiable Credentials (VCs) so it can support user-control, and privacy identity management.
- With the development of reputational score system that uses issuer credibility, endorsement network and validated badges to determine trustworthiness.

By putting forth a cohesive framework that blends algorithmic reputation modeling, blockchain backed credential verification and Decentralized Identity management, the study will fill a significant role in digital identity and trust systems. Its ability to completely transform our abilities, accomplishments and reputations are portrayed and trusted in digital world. It will provide a tamper-proof credential system that goes beyond reputation models exclusive to a given platform (for example, centralized e-learning certificate, LinkedIn). By promoting user-sovereignty and privacy through a Decentralized Identification system it will lower reliance on outside authorities. It will provide an architecture for widespread use of Blockchain enabled micro-credentialing by governments, Academic institutions, and digital platforms.

RESEARCH QUESTIONS:

1. In which ways professional's identification systems use blockchain technology to guarantee the verifiability, integrity and authenticity of digital credentials based on badges?
2. How might verifiable credentials (VCs) and Decentralized Identifiers (DIDs) can improve integrations, privacy and user authority?
3. Can a decentralized, badge-based system strengthen trust, transparency and resilience to tampering when comparing with the existing centralized reputation system?
4. When deploying badge issuance and verification on blockchain technology, what are the technical and operational tradeoffs (such as latency, cost and scalability)?
5. How can a map of institutional endorsement and certified badges can be used for algorithmically measure the reputation while maintaining security against Sybil attacks?

HYPOTHESIS:

1. Blockchain based Smart contract enabled badge issuance will drastically lower the possibility of professionals credentials for being fraudulently altered or without their authentication.
2. When compared to the existing system, centralized user identification models, the combination of decentralized identifiers (DIDs) and verifiable credentials (VCs) will offer better privacy and self-sovereign identity management.
3. In contrast to the centralized solutions, blockchain based badge system will have significant latency and

greater operation expenses but with improved security and trust.

Literature Review

As the traditional credentialing and identity management systems has become less useful, the search for reliable, verifiable, and decentralized reputation systems has grown. Nowadays, professionals rely more and more on digital platforms to show their skills and achievements, like LinkedIn. The flaws of centralized collections and separate learning credentials have become clearer. But these type of systems often don't let users to give control or verify things due to this reason they are not clear.

Blockchain identity technology is providing decentralized, strong substitutes with the existing centralized identity management. Liu et al. (2020) noted that the self-sovereign identity (SSI) is a prevalent paradigm made possible by verifiable credentials (VCs) and decentralized identifiers (DIDs) when he analyzed Blockchain Identity models [1]. These frameworks will minimize the need of centralized authority when enable the individuals to control their identities independently.

Kontzinos et al. (2024) showed a blockchain based network for issuing academic badges in higher education, which is emphasizing more control and transparency [2]. In a related case, Caramihai and Severin (2023) highlighted how blockchain technology can be used to issue diplomas, enhancing the legitimacy of academic credentials [3].

When working towards evidence-based and modular learning validation is reflected in digital badges. According to Kishore et al.'s (2021), immutable credentials record increased student mobility and employer trust, which is developed and tested on a blockchain-based micro-credentialing platform [4].

Maestre et al. (2023) demonstrated that the badge metadata (issuer, endorsement, etc.) may be used for complex trust inference by securing micro-credentials using Mozilla Open Badges standard with blockchain hashing [5]. A proof-of-existence verification badge system was presented by Choi et al. (2019), who defined badges as blockchain-recorded accomplishment with timestamps [6].

In decentralized ecosystems, Algorithmic reputation systems are frequently used to establish a trust. While using attribute-weighted scoring, Zhao and Liu (2019) combined the reputation with blockchain-based identity systems and confirmed that smart contracts can be used to enforce trust propagation [7]. By

integrating verifiable credentials with decentralized feedback loops in e-commerce, Doğan and Karacan (2023) expanded on this, by creating a reputation system that protects privacy and is resistant to manipulation [8]. Self-sovereign identity and blockchain-based badges can help struggle in reputational bias from centralized institutions, according to Grech et al. (2018) created a blockchain in the technical and vocational education (TVET) sectors [9].

With a focus on extensibility and interoperability, Gräther et al. (2018) created a blockchain-based lifelong learning passport based on Ethereum smart contracts and Open Badges [10]. Strong resilience to credential forgery was demonstrated by Tariq et al. (2022) permissioned blockchain-based system for accreditation and degree verification [11].

Xu (2024) talked about how blockchain technology and individual's credential IDs might streamline the verification of academic credentials, enabling on-chain lookup for decentralized recruiters and employers [12]. The integration of blockchain and badges into a single verifiable reputation architecture is still in its initial stages, despite the fact that both have been extensively researched separately. Few systems are associated with issuing badges with scoring and decentralized endorsement. Furthermore, the majority of solutions lack adaptation to professional and freelancing ecosystems and are restricted to academic settings.

Decentralized Identity (DID) systems are a huge change in how people keep track of their identities. They are based on standards like the W3C Verifiable Credentials Data Model. Instead than relying on centralized identity providers, users can now manage their own IDs and credentials. Papaioannou and Mantzonis (2024) claim that DID-based systems with credentials that can be checked make online interactions fair and hard to change. They also provide a platform for decentralized trust modelling in online markets and institutional verification systems IEEE Link. [13]

Blockchain is an excellent technology for digital badge and credential systems because it can not be changed and can be checked anytime. Pondkule and Kothari et al. (2025) by using blockchain technology they made a big difference to create a system for managing documents for schools and universities. This system makes it easier to safely, without any central authority issue and check academic records and credentials. [14]. Gil et al. (2025) talk about how diplomas on the European Blockchain Services Infrastructure (EBSI) are issued. They showed how the Verifiable Credential

standard makes academic recognition portable and safe [15]

The emergence of blockchain technology presents a promising opportunity for creating decentralized and transparent reputation systems. The fundamental features of blockchain, including its immutability, transparency, and decentralization, can effectively address the limitations of traditional reputation systems. (Akaba et al., 2020) [16]. Utilizing blockchain technology allows for the secure storage and verification of reputation data, reducing the chances of tampering and manipulation. Additionally, blockchain-based identity management solutions are being developed to create self-sovereign and verifiable digital identities. (Ghosh et al., 2021) [17].

Blockchain-based reputation systems are strengthened by cryptographic security and distributed consensus methods that holds the potential to transform digital interactions by offering a reliable and transparent framework for evaluating the trustworthiness and credibility of individuals and organizations within online environments.

Research Methodology

Design Approach

This study is followed by the Design Science Research Methodology (DSRM) principles, which will produce a decentralized system for professional reputation that will use smart contracts, blockchain technology and credentials which are verified. In the first step find the major problem: there are not such online platforms which are trustworthy and are able to work with each other to show their professional achievements. This shows that how important it is to have a decentralized system that can get around the problems with centralized reputation systems.

There are no reliable, open, and compatible ways to show off professional achievements online. From this problem it is clear that we need a decentralized solution which can work around the problems with the traditional centralized reputation systems. After that, specific goals and design requirements are created which make it easier to create the artefact. Some of these are self-sovereign identity, decentralized endorsement, verifiable badge issuance, and security which are against assaults like badge inflation or Sybil attacks. After that, the artefact is created utilizing smart contract design and implementation, a model for active trust computation, and a DID-based identifying framework. A workable prototype that integrates front-end elements with the help of IPFS-based metadata storage is constructed and put on.

System Architecture

Following are the main elements of the proposed framework:

1. Badge Issuers: Approved institutions will use smart contracts for perfect verified badges.
2. Holders: People who are in-charge of badges that are linked with their Decentralized Identification.

3. Verifiers: To confirm the legitimacy of badges organizations uses Blockchain Technology.

4. Blockchain Layer: Hyperledger-based smart contract backend or Ethereum.

5. Storage Layer: IPFS for badge metadata including timestamp, issuers and description.

6. Identity Layer: W3C-compliant Verifiable Credentials and Decentralized Identifiers.

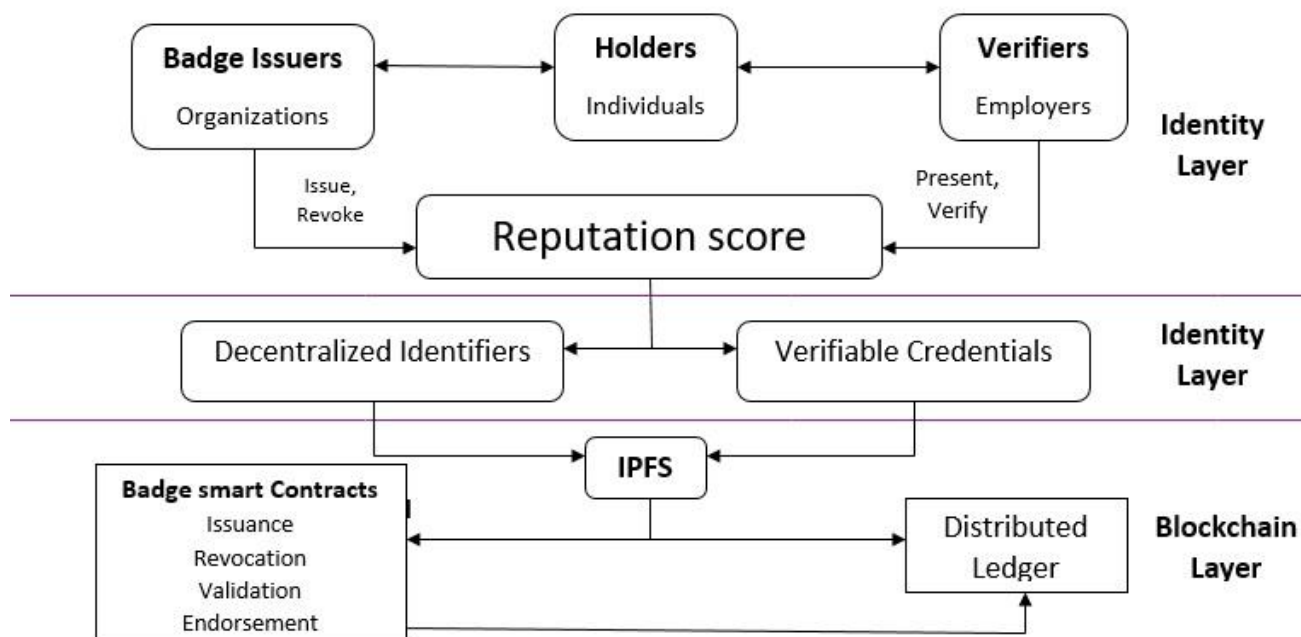


Figure 02: Block Diagram

Expected Results and their Utilization:

The proposed blockchain based badge identity framework is thoroughly tested to check its functionality, performance, security and privacy. A prototype of the system is developed and it is tested on the Ganache local blockchain and Ethereum Ropsten testnet.

The proposed system showed as it is working well when it was tested. All badge issuance and verification actions are working successfully. The system linked badge events to decentralized identifiers (DIDs) and metadata on IPFS correctly. This will let issuers and holders to talk with each other in a way that they can check it. Smart contracts sent the expected transactions receipts, which verified that they are working well.

At the end, a comparison is made between LinkedIn endorsement and Coursera certificates and proposed framework and it showed that the proposed framework is better when it comes to verifiability and user control. The system's decentralized design makes it easy to check and hard to change, which is making people more trust professional credentials.

The study shows that the proposed system is technically working sound and is safe from many risks that decentralized identification system can face. It is offering a believable alternative to the centralized reputation system by making the combination of openness of blockchain with the flexibility of badge-based credentials.

Experimental Setup/Equipment Required:**Testing Tools**

Tools	Function
Ganache CLI/GUI	Local Ethereum blockchain simulation

Ropsten	Ethereum public testnets for real-world testing
Mythril	Smart contract security analysis
Python	Data analysis, graph simulation for reputation scoring

Software Tools

Tools	Function
Node.js + NPM	Backend development and package management
Solidity	Smart contract programming language
Ganache	Local Ethereum blockchain simulator
MetaMask	Wallet and Web3 integration
Ethers.js / Web3.js	JavaScript libraries for blockchain interaction
IPFS	Decentralized file storage for badge metadata
uPort / DID Resolver Library	Decentralized identity integration

Future Work:

This study will establish a framework on Blockchain – based Technology for transparent badge reputation system, but future for this is to be more advance in scalability and interoperability. In this regard, enhancement an include exploring 2-layer scaling and other way is Blockchain to reduce cost and latency, as well as ensuring through W3C Decentralized Identifiers (DID) and Validation Credentials (VC) standards. Reputation system model can be improved wit Machine Learning algorithms and privacy can be strong using homomorphic encryption.

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