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Immunity credentials using self-sovereign identity for combating COVID-19 pandemic

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ABSTRACT

The refugees and migrants are not recorded generally and deemed invisible by governments without providing them with identity and welfare services. The COVID-19 pandemic has badly impacted the economy, and the poor migrants and refugees have suffered most due to the closure of industries and informal sectors. Lack of legal identity made them more vulnerable and excluded them from getting benefits of even meagre government support and welfare schemes. Self-sovereign identity is a form of distributed digital identity that can provide immutable identity with full user control and interoperability features. Self-sovereign identities also ensure the privacy and security of personal information. SSI model can effectively provide migrants and refugees with an effective legal identity and include them in government welfare schemes and other schemes run by non-governmental agencies. Also, SSI can be used for uniquely identifying the people who have been already vaccinated or tested negative from COVID-19 within a stipulated time. This paper reviews the aspects of SSI application during the pandemic situation like COVID-19.

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1. COVID-19 concerns for immigrants

Undocumented immigrants have significant economic impacts and are more vulnerable to the spread of COVID-19. They could be exposed to substantial health risks from a pandemic. According to the US Department of Agriculture, more than 50% of farm employees are without proper documentation. Due to the current COVID-19 pandemic situation and the Social Isolation Guideline, migrants workers are most affected, and the food supply chain disturbed. Government agencies are trying to help citizens in distress to provide them with relief material and foodgrains. Still, most migrants lack proper identity documents, and they have no access to health protection kits. They also do not have access to health insurance and can not afford to take leaves or stay at home in case of illness due to financial constraints. These conditions make them most vulnerable in such conditions [1].

Despite Social isolation in the current coronavirus, the COVID-19 pandemic affects society as a whole, but indeed more radically on those with less capacity to deal with its effects. Additionally, the

susceptibility of people residing under undocumented status is compounded by many challenges, as their legal, economic and social status is not equal to that of lawful residents. Also, circumstances, such as their inability to connect with the local population and language, restrict them to information, services, resources and protection that are timely and understandable [2]. Table 1.

The pandemic of COVID-19 highlighted most health systems' vulnerability, such as those of privileged nations. Such fragility raises the risk of restricting the access of sections of the population to health care and reveals another aspect of the vulnerability of the lives of undocumented migrants in the context of the health crisis [3].

Various human rights agencies and legal residents are critical to government for doubting the use of collected information to track and violating the privacy rights and undermine civil rights. On the other side, the migrants suffer from the fear of their detention and deportation if found in violations of residency requirements. Their fears push them to live in precarious conditions and with anti-immigration law restrictions in many countries. Undoubtedly, undocumented migrants will willingly follow the digital platforms that can trace them and law agency can deport or detain them. Such a situation increases other public health emergency chances.

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Table 1
Blockchain Applications in Covid-19.

| Author | Application | Techniques used | | | | |
|-----------|--|-----------------|-----|----|----------|-------------------------|
| | | Blockchain | IoT | AI | Big data | Self-sovereign identity |
| [23] | monitoring, surveillance, detection and prevention of covid-19 | ✓ | ✓ | ✓ | ✓ | × |
| [24] | detection & prediction of covid-19 risk | ✓ | | ✓ | | × |
| [25] | predicting the spread of covid-19 | ✓ | | ✓ | | × |
| [26] | creating immunity certificates | ✓ | | | | × |
| [27] | medical cooperation and scientific research for the spread of covid-19 | ✓ | | | | × |
| [28] | recognize COVID-19 patients | ✓ | | ✓ | | × |
| [29] | tracking effects of COVID-19 | ✓ | | | | × |
| [30] | fight and control outbreaks of COVID-19 | ✓ | | | | × |
| [31] | donation tracking COVID-19 infected victims | ✓ | | | | × |
| Our paper | creating immunity credential | ✓ | | | | ✓ |

2. Blockchain and Self-Sovereign identity

Possessing a legal identity can help non-documented migrants access health facilities and other support schemes during a pandemic or emergency period. It helps governments identify the weaker section of society who are most vulnerable to such pandemic situations to counter the pandemic and support the population by uniquely identifying and tracking them.

Identity would make it easier for undocumented migrants to be connected to health care and other assistance forms during the COVID-19 pandemic. It can also aid government efforts to contain the virus, such as monitoring and tracing infected and vulnerable populations. Blockchain-based self-sovereign identity (SSI) can aid migrants without any lawful documents with a legal identity that will not threaten them [4 5 6]. Additionally, Blockchain initiatives focused on SSI can significantly help government entities in their operations [1 2 3 7]. An SSI must make it possible for users to make claims, while the healthcare service should check that users' claims are correct or not. There is no accepted or defined criteria that explain the features of a self-sovereign identity but there are some relevant SSI characteristics necessary that have been given below:

- The user should control the knowledge sharing related to his identity.
- Protection of privacy is assured.
- Personal information cannot be shared without the consent of the user.
- Unauthorized entities should never be in a position to manipulate knowledge.

Blockchain-based self-sovereign identities often store and exchange personal identity-related data. Blockchain makes sure that the data is unknown to mutate, guarantees confidentiality and privacy and that the user can exchange the data based on consent [8,9]. With SSI, the individual can use an application to confirm who they are and share personal identity information with others. For example, like COVID-19 test results, certificates can be saved and retrieved securely since blockchain technology is similar to immutable. An independent verifier assures that the correctness of self-sovereign identities, as shown in Fig. 1.

Individuals can exercise their fundamental right through a blockchain-based self-sovereign identity: to be remembered as a citizen and "visible" in a crisis like the COVID-19 pandemic. The architecture provided by the blockchain-based self-sovereign identity project is based on considering the individuals as sovereign agent and the state system's decentralization. Blockchain-based SSI can also have a positive impact on access to the services of NGOs.

Blockchain-based identity management systems are a secure and efficient solution to handling patient data, safeguarding

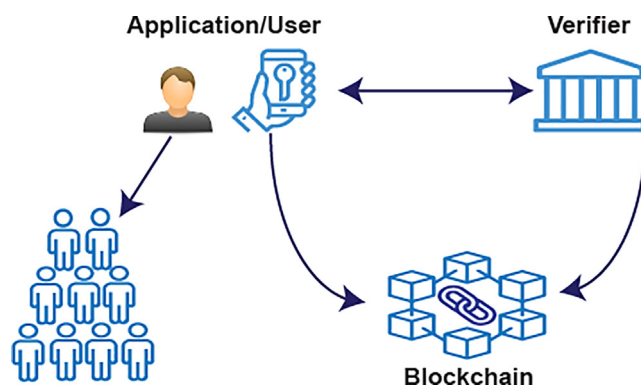


Fig. 1. Blockchain-based self-sovereign identities architecture for healthcare.

patients' health care records and personal information [10 11]. A similar concept to blockchain-based self-sovereign identities projects defines as a patient-centred framework that enhances medical information protection [12].

Blockchain technology eliminates the need for intermediaries from the healthcare ecosystem. Additionally, it prevents unnecessary state regulations and transfers of authority to a deregulated blockchain-based platform. The privacy factor is another positive aspect of the acceptance of blockchain-based self-sovereign identities in healthcare. Private and confidential information are less vulnerable to misuse and attacks because of their decentralized peer network, allowing the patient to monitor and control their data without compromising protection, and autonomously selecting health-care stakeholders to provide customized services [13 14 15 16].

The creation of a blockchain-based self-sovereign identity with the potential of providing medical information could significantly affect the migrants lacking on lawful documents and other lawful citizens in society, given the characteristics of blockchain-based applications. Adopting may make it possible for this group to be inclusive and help the host country by slowing the virus's spread. The idea of adding information on medical history will provide an opportunity for these people to obtain medical aid. They can utilize the self-sovereign identities to certify that they are either immune or have been negatively tested for COVID-19. This opportunity could benefit the undocumented population and community in avoiding widespread pandemic.

The blockchain-based SSI is used to provide access to undocumented people's fundamental rights, which should become standard and even more critical in regularly responding to crises. As recommended by the International Organization for Migration [2], building trust among undocumented migrants from the start of implementing these technologies is necessary to allow users to trust the technologies they are familiar with. Principles of data protection and ethical considerations aim to build confidence in

applying any technology within a historically excluded community, ignored by the system, and living in fear of repatriation.

3. Self-sovereign identity for Covid-19

The COVID-19 Credentials Initiative (CCI) focuses on the digital identity that enables entities to verify their health condition using W3C Verifiable Credential, reflecting that they have recovered from the pandemic.

As already mentioned, SSI helps identify individuals and provide a layer of assurance and safeguard for their personal information by securely placing the data in the hands of the individual instead of any third party involvement to verify the identities. In the COVID-19 pandemic crisis, blockchain-based self-sovereign identities interest grew dramatically. Prominent enterprises and researchers are working on developing digital certificates [17]. The pandemic affected millions of people financially and caused considerable economic loss, but governments aim to reopen economic activities. Solutions have been emerging to present and store accurate digital health information data. Top organizations actively research to develop confidential and secure methods for certifying the results of COVID-19 research. These findings would encourage all organizations to return to their work and confidently resume their activities [18].

Digital credentials will provide the patients with verifying their health conditions and immunity against various diseases. These digital credentials are considered as a health passport or immunity credential showing their immunity. Such certificates will help the organizations and individuals in verifying them at workplaces [19]. These digital passports act similar to standard passports that guarantee identity and citizenship; similarly, health passports will guarantee health immunity against Covid-19, accurately identifying and linking COVID-19 test status etc. [20].

3.1. Privacy-Preserving credentials

As a global network of technology providers and health organizations, the COVID Credentials Initiative (CCI) [21] has recently been launched to collaborate to tackle the spread of COVID-19. The project includes major blockchain-based identity management such as Evernym, UPort and Microsoft[2222], with more than a hundred organizations from around the world. The purpose of the CCI is to deploy verifiable credential systems to protect privacy using digital W3C credential.

The parts appropriate to any specific local project usually create credentials, anything in which there are issuers and holders and verifiers of the particular population [3]. This relationship includes four work streams based on different aspects and concerns of verifiable credentials: use cases, laws and governance, resources, technology and communications. The tools and technology workstream built the first version of a COVID governance framework compliant with the CCI initiative [23].

3.2. Blockchain and COVID-19

A summary of blockchain applications in COVID-19 pandemic related tasks has been summarised in Table-1. Wang and Tang [24] demonstrated how new technologies could be used to counter the spread of COVID-19. The paper highlights how the Internet of Things, Big Data, Blockchain, and Artificial Intelligence can reliably determine the disease's spread. These technologies are also useful in the diagnosis and surveillance of the disease. The paper discusses real-world use-cases and current blockchain implementations to enable tracking drug shipments to the patient's home in China. The study's goal is to demonstrate the effectiveness of

state-of-the-art technologies to prevent the outbreak of COVID-19. The study did not report how the implementation was carried out. Also, Torky and Hassanien [25] proposed blockchain technology to identify suspected cases of the COVID-19 virus. The authors used a decentralized blockchain database to store information and medical data on reported cases of COVID-19. Early identification of patients with COVID-19 relies on technology, such as a medical scanner and a surveillance system. Similarly, Nguyen et al.[26] suggested how to predict COVID-19 pandemics and how to prevent similar outbreaks in the future. Using AI and blockchain, an immense amount of data can be processed from intricate patterns. It introduced a blockchain-based approach to help manage the donation and monitoring of health supplies. However, the implementation is not explained in depth.

The use of blockchain to create generalized immunity certificates has been demonstrated by Bansal et al. [27]. The authors also suggested using immutable blockchain technology to prevent false report and information. The solution proposed involves addressing the problems of confidentiality and privacy of test-taker users. However, the authors did not suggest a particular implementation approach or design proposal. Resiere et al.[28] suggested a blockchain-based solution to reshaping the health care system in the Caribbean. They have sought to achieve medical cooperation and a joint research study to tackle the spread of COVID-19. A blockchain company in Canada recently launched a safety system called Civitas, intended to assist local authorities in tracking the effects of COVID-19. This app incorporates the blockchain to ensure users have the freedom to leave home. Civitas is a telemedicine service whereby doctors can keep track of their patients' symptoms, send them advice on the drugs they should use, and follow the healthcare methods [30].

An Hashlog created by Georgia health tech companies Acoer [31] also developed a distributed ledger solution to fight and control the outbreaks of COVID-19. Hashlog potential offers real-time alerts on the virus's spread by monitoring infected people's movement to avoid further infection. The Hyperchain is a blockchain-based project for donation tracking network to help governments and healthcare organizations in the donation process to the COVID-19 infected victims in China. Hyperchain ensures transparency of the donation case from the beginning to the endpoint. The Hyperchain would connect up to millions of nodes, making it possible for more people to access donated goods and medical equipment from the factories [32].

Numerous innovative technologies, including blockchain and the Internet of Things, are being explored to enhance COVID-19 response. Still, current efforts have not provided technical details except [29], where the authors demonstrate their in-depth learning model implementation details. In addition to the above-listed techniques, blockchain technology cannot be used to minimize the COVID-19 spread. Blockchain has been suggested as a possible solution to monitor the spreading of false information or as a technology to provide a platform for other technologies. None of the studies explored the monitoring and tracing of COVID-19 test-takers through connected healthcare records and digital medical passports.

Therefore, we propose the blockchain-based Self-sovereign identity-based immunity credential to offer the tracing and tracking of COVID-19 test-takers. The use of self-sovereign identity provides an effective decentralized identity system. The proposed solution does not require blockchain storage and can be applied without reliance on-chain storage.

3.3. Self-sovereign identity for immunity credentials

Focused on public collaborations, companies are finding ways to respond to the global pandemic. Demand for immunity certifi-

cates is at an all-time high, which pushes some companies to force out their products, generating a wide range of offers. Recently, Apple and Google announced a joint effort to introduce an Exposure Warning system that promises to integrate privacy-preserving Bluetooth contact monitoring technology [23]. Blockchain-based technologies provide immunity credentials for several other companies that can protect personal information (PII).

For example, Civic announced recently proof of health checks for health key companies accessible via Civic Wallet [33]. This technology allows users to monitor who they give and how they share medical records. It will enable users to generate cryptographic proof to demonstrate bits of information about disclosing the whole underlying identity.

The advantage of self-sovereign identity is that it provides user-controlled information and uses zero-knowledge proof to efficiently control data use. e.g., if you vaccinated for COVID-19, then while entering the office/home, you might tell the machine that you have vaccinated without providing your personal identity information," said Vinny Lingham, CEO and co-founder of Civic." The machine uses a series of cryptographic tests and assumes you had the vaccine and are authorized to enter. The machine will not save your transaction identity data.

Onfido develops "immunity passports" through its identity model. In doing so, credential providers can verify the relevant information about a person or organization and issue verifiable credentials to that person, enable individuals to hold multiple digital credentials on their phone and accept or reject requests for information sharing with institutions. This model is already being built for public use; in May, Sidehide partnered with Onfido to prove immunity to hotel bookings in hopes of making travelling safe for people [34].

Pangea launched a COVID-19 immunity biometric smart card to assist the aviation and tourism industries. At the same time, ID. Now and the UK Government consider issuing immunity certificates using video identification and document recognition software. DrNote.com also offers an immunity passport COVID-19 to the US market after its initial launch [34]. Nevertheless, anonymity is the main focus of many digital identity providers, such as Kosmos biometric identity solutions.

Kosmos' platform allows individuals to verify the credential's validity, and verifiable credentials carry the actual value as an accredited credential organization issues it. And as long as credentials can be verified in real-time, individuals have a record that can verify their validity. It also focuses on the fact that it is not public due to many relevant Personal Identifiable Information (PII). Fig. 2 presents the Kosmos blockchain-based SSI architecture.

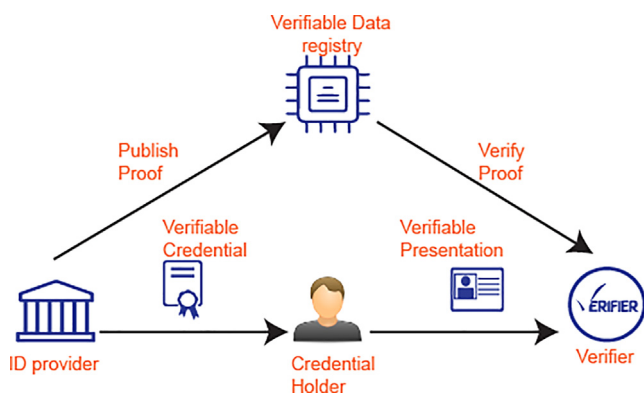


Fig. 2. Blockchain-based SSI architecture [22]

Like many other long-lasting documents, such as driver licenses and college identity cards, immunity credentials may become invalid due to potential infection and transmission. It opens the door to a platform allowing organizations to check that they have renewed and modified their credentials to prevent unauthorized access to a system or building. Individuals return to function with Kosmos' solution. It will be as simple as scanning and authenticating a QR code, giving explicit consent to send results using their live ID to show they will have the result and are COVID-19-clear.

Another application with similar architecture as kosmos can help get an airfare ticket online based on a timestamp at the airport. It helps flyers do this in phases if they are supposed to be completely clear 24 or 48 h before travel, making sure they are visible when purchasing the ticket and arriving at the airport [35].

4. Further research

The self-sovereign identity provides opportunities to fight against the COVID-19 pandemic situation. There are various examples among them: the secure sharing of the medical information and attestations controlled by the patient. Undocumented workers play a major role in any country's economy, and in the current pandemic COVID 19 situation, they're unable to access basic aids and medical services. The self-sovereign identities enable the undocumented worker to have an identity to access aids and medical services. The SSI provides opportunities to the government, and research is needed in the technical, institutional, and social science aspects to fully use SSI in various government sectors like health-care and finance. Finally, the COVID-19 situation enables the government to develop the blockchain-based self-sovereign identities solution for the government.

5. Conclusion

Different countries and organizations are working towards developing systems an mechanism to detect and create a profile of the people who have already recovered and immune to the COVID-19 pandemic based on vaccination, recovery from disease and other defined parameters. These immunity validations in the form of immunity passport will allow validating such population for allowing them in different activities. Although these functionalities are very useful in curbing the pandemic, few raise human rights violations and interference in their personal liberty. Other factors affecting such immunity certificates/ passports are the accuracy of data. Blockchain has effectively countered the issue of anonymity, accuracy and authentication issue that can also be very useful in case of the COVID-19 pandemic. The blockchain-based SSI framework will accurately solve the issue of identity that will preserve the identity information and control over their personal identity details.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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