Blockchain Based Covid – 19 Trusted Tracking System

Kumar Satyam and G Vishnu

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Kumar Satyam
B.tech In Computer Science &
Technology
Galgotias University
Greater Noida , India
imdsatyam@gmail.com

Vishnu G
B.tech In Computer Science &
Technology
Galgotias University
Greater Noida , India
ganeshanvishnu@gmail.com

Abstract - The sudden development of the COVID-19 pandemic has uncovered the limitations in contemporary healthcare systems to handle public fitness emergencies. it is obvious that adopting innovative technology including blockchain can help in effective planning operations and useful resource deployments. Blockchain technology can play an essential position inside the healthcare region, consisting of advanced clinical trial records management by decreasing delays in regulatory approvals, and streamline the verbal exchange among numerous stakeholders of the supply chain, and many others. furthermore, the unfold of misinformation has intensely elevated for the duration of the outbreak, and existing platforms lack the capability to validate the authenticity of records, main to public panic and irrational behavior. for this reason, developing a blockchain-based totally monitoring gadget is vital to make sure that the statistics received through the general public and government organizations is reliable and truthful. on this paper, we evaluate diverse blockchain packages and opportunities in combating the COVID-19 pandemic and develop a tracking system for the COVID-19 data accumulated from various outside resources. We advocate, put into effect, and evaluate a blockchain-based totally gadget the use of Ethereum smart contracts and oracles to track pronounced facts related to the wide variety of recent instances, deaths, and recovered instances acquired from depended on sources. We present targeted algorithms that seize the interactions between stakeholders in the network. We gift security evaluation and the fee incurred via the stakeholders, and we spotlight the demanding situations and future guidelines of our work. Our work demonstrates that the proposed answer is economically viable and ensures data integrity, safety, transparency, facts traceability amongst stakeholders.

Keywords - Blockchain, COVID-19, Coronavirus, Ethereum, Trusted oracles, Smart contracts, Traceability, Tracking system, Transparency.

I. INTRODUCTION

The coronavirus (COVID-19) outbreak in past due 2019 caused a global health emergency around the sector. in just over 3 months, the number of coronavirus new cases has escalated to greater than one million global. The fast transmission of the virus leads to new cases being pronounced globally with the aid of the hour. simultaneously, the range of deaths and infections keeps to upward thrust quick. consequently, the COVID-19 pandemic has enforced lockdowns and social distancing pointers affecting global economies negatively. It has led to the cancelation of many vital world's sports, together with sporting events which includes the Tokyo Olympics and Dubai Expo. As a result, government officers and scientists throughout the globe had been rigorously working closer to growing a therapy and predicting the potential growth

trajectory of the virus since the first few instances that had been reported to the sector fitness employer (WHO).

further to forecasting the casualties and boom of COVID- 19 instances, many reports additionally be counted the active and recovered instances gathered from countrywide and country government health organizations at the side of neighborhood media reviews.

In truth, every day, a new set of baffling records points are mentioned concerning the variety of positive and bad checks, patients hospitalized, deaths, sanatorium beds occupied, ventilator shortfalls, etc. these numbers permit the officers and public to song the progress of COVID-19 in actual time and as they emerge as available, making it a information-pushed pandemic. then again, those numbers pose a primary trouble as choices based totally on such information are frequently imperfect and incomplete. statistics verification and validity in pandemic control are vital for conclusions and recommendations given to the general public which are based totally on recorded or reported statistics facts. accordingly, the advent of monitoring apps turns into necessary and treasured to assist prevent the unfold of this virus and keep facts satisfactory and integrity. further- extra, tracking valid information is critical to monitor the development of the pandemic. Tech giants, researchers, and healthcare officials commenced using contract-tracing cellular apps that use Bluetooth- based proximity tracing or geolocation monitoring capability to assist music COVID-19 instances. numerous agencies have even developed map-based dashboards to track information. knowledge the dynamics of the pandemic calls for correct statistics to expect how fast the disorder spreads, whether or not the countermeasures are effective or no longer, and the impact it has on the lives of humans. however, records available on line may not be ideal as it's far susceptible to facts manipulation.

consequently, innovative technology inclusive of deep getting to know, gadget learning, synthetic intelligence (AI), and blockchain may want to assist fight the crisis. Blockchain generation has the ability to revolutionize numerous industries, along with finance, deliver chain, and the healthcare sec- tor. Blockchain is a decentralized era with awesome in-built features along with impenetrable statistics infrastructure, transparency, and cryptographic encryption tools. it is a allotted ledger containing a sequence of blocks. Blockchain's decentralized platform is tamperproof because of its underlying cryptographic era, that is used to authenticate participants inside the network.

furthermore, it calls for quite a few sources that allows you to alter transactions delivered to the blockchain community because once a transaction is established and tested, then it gets chained to preceding transactions with a unique hash. therefore, manipulating one transaction could trade this hash, and all contributors could be alerted making it nearly

impossible to replace or delete information. furthermore, facts stored on the blockchain are made available to all contributors of the community, making sure transparency among contributors.

Blockchain technology has numerous abilities use cases that may help address the modern pandemic crisis. it could be used to simplify the scientific trial techniques for vaccines and capsules, raise public awareness, transparently music donations and fundraising activities, and act as a reliable statistics tracker. in this paper, we recognition at the statistics monitoring use case as blockchain allows confidentiality and accept as true with to be maintained in information series and reporting. COVID-19 data can be amassed from several trusted resources inclusive of WHO, the center for sickness manage (CDC), and the Institute for health Metrics and assessment (IHME). As a result, constructing a decentralized monitoring system that retrieves publicly to be had statistics and records from authoritative resources to show on decentralized applications and dashboards is important as this platform imposes security regulations and statistics privateness.

It needs to be referred to that constructing a blockchain platform to music COVID-19 transmission is essential, as among the currently evolved structures are at risk of hacking and cyber- criminals. desk 1 highlights the benefits of imposing a blockchain-based answer over a traditional centralized answer in numerous factors, such as data managing, best assurance, fault tolerance, and so forth.

as an instance, the world economic forum highlighted that hacker are using coronavirus maps to unfold malware. these attackers impersonate interactive maps that song the unfold of the ailment. through doing so, they trick users into giving their contracty records which include usernames, passwords, and credit score card numbers. The hackers then use this personal datum to sell it on the deep internet or financially take advantage of human beings. further, some hackers use fraudulent cell apps as fake coronavirus tracker apps to trap users into paying a ransom to avoid leaking their social media statistics. moreover, the public is continuously uncovered to misinformation and spams of faux information. Blockchain era can get rid of the issues confronted by means of centralized information structures. It introduces immutability and information provenance even as doing away with single point of failure inside the system. consequently, with blockchain data tracker, any consumer with internet get admission to can examine, in a few quick clicks, actual-time facts about the COVID-19 virus in a at ease and trustable manner. The number one targets of this paper are to check various use cases of blockchain generation for COVID-19 and increase a blockchain-based relied on facts tracking gadget. the main contributions of this paper are summarized as follows:

We evaluate various blockchain programs and possibilities for preventing the COVID-19 pandemic. We endorse a framework along with the algorithms that define the operating standards of the proposed blockchain- primarily based tracking gadget, provided an in-depth series diagram summarizing stakeholder interactions in the blockchain-based tracking machine, tested, and verified diverse eventualities of the overall system functionalities.

II. BACKGROUND

On this phase, we offer historical past statistics related to the COVID-19 pandemic, and we give an explanation for the significance of adopting blockchain era in fighting this crisis.

2.1 COVID-19 Pandemic

Coronavirus disease (COVID-19) is an infectious, acute, respiratory infection as a result of a unique coronavirus SARS-CoV2. Coronaviruses are a circle of relatives of viruses which can reason ailments which include the commonplace cold, intense acute respiration syndrome (SARS), and the center East respiratory syndrome (MERS). Early COVID-19 instances were related to a seafood market in Wuhan, wherein wild animals have been traded, suggesting that the virus was broadly speaking transmitted from animals to human beings. Transmission is thought to occur thru breathing droplets from coughing and sneezing, as with other respiratory pathogens. Virus discharged in breathing secretions can infect other individuals through direct contract with mucous membranes. The virus also can persist on surfaces to varying durations and degrees of infectivity. In March 2020, the world health organization (WHO) declared the COVID-19 outbreak a deadly disease. As of June three, 2020, extra than 6.5 million infection cases had been mentioned across a hundred ninety countries and territories, resulting in more than 384,000 deaths.

2.1.1 Symptoms

People inflamed with COVID-19 have had a extensive variety of symptoms mentioned, ranging from moderate signs to severe contamination. symptoms might also appear two to 14 days after expo- sure to the virus. The signs and symptoms and signs of COVID-19 encompass, however not restricted to fever or chills, cough, shortness of breath or difficulty in respiratory, fatigue, muscle or frame aches, headache, lack of taste or odor, sore throat, congestion or runny nostril, nausea or vomiting, and diarrhea. some humans can also have only a few signs, even as others can also haven't any signs and symptoms in any respect. Older adults and people who have critical underlying medical conditions like heart or lung disorder, diabetes, persistent kidney, or liver disorder are at a better danger of growing more serious complications from COVID-19 contamination. headaches can include pneumonia, organ failure, heart issues, unexplained blood clots, acute kidney harm, more than one organ failure, extra viral, and bacterial infections main to loss of life.

2.1.2 Preventive Measures

That time there is currently no vaccine to save you COVID-19 sickness or medication from treating it. consequently, preventive measures are crucial considering the unfold of the virus to reduce the risk of encountering it. most of the preventive measures currently put in vicinity: washing arms with cleaning soap or alcohol-based totally hand wash for at the least 20 s, training social distancing and preserving a distance of at the least 2 meters aside, wearing surgical mask, and avoiding contracting the face, mouth, eyes, and nostril. different preventive measures encompass cleansing high-contact hard surfaces frequently, using regular household cleaners, overlaying coughs and sneezes, staying domestic, and monitoring one's fitness. humans are recommended to be alert for signs and symptoms and look

ahead to fever, cough, shortness of breath, or other signs of COVID-19 to prevent the spread of the virus and transmitting it to others.

2.1.3 Global Impact

The virus isn't always best affecting the fitness of human beings but additionally impacting their lives and the worldwide economic system. many countries have declared restrictive measures, along with lockdown and live at home orders, every day comprise and mitigate the pandemic. As a end result, more than 39 billion humans, or 1/2 of the arena's population, had their motion restrained by early April. The lockdown additionally implied that most facilities, markets, and agencies are day-to-day be briefly closed, most public shipping suspended, and creation paintings halted. As a result, COVID-19 no longer handiest has implications on humans' health but appreciably impacted corporations and the worldwide economic system. every day the suspension of many groups, the monetary slowdown turned into profound, and the damage became critical. The financial harm resulting from COVID-19 includes deliver chain interruptions, misplaced everyday prism, spiking unemployment, defaulted loans, the chance of major authorities' bailouts, and meals disaster.

2.1.4 Mitigation Efforts

In addition to the preventive measures which individuals can comply with, there have been mitigation efforts installed region by means of governments and organizations to contain the virus. as an example, several applications internationally have been constructed to tune COVID-19 patients and tracing their contacts. correct identification of cases, contract tracing, and isolation can rarely be achieved with conventional methods, and using centered cellphone apps could incredibly enhance the efficiency of those strategies. as an example, a few leading public health governments have built numerous smart answers that detect instances of COVID-19 and manipulate it unfold. a number of those smart answers are mobile contract-tracing packages which could come across whether or not an person has been in contract with someone infected with COVID-19. these applications use the Bluetooth era that enables customers to exchange anonymized IDs saved in an encrypted form in order that their fitness government can effortlessly contract individuals at threat. those programs also can warn their customers while an infected person is close by, thereby preventing feasible infection. They can also track whether an infected person is respecting the social distancing tips. One instance of these programs is ALHOSN UAE app that can be downloaded free of rate while ensuring a high degree of privacy safety to its users, way to synthetic intelligence and different tools. further to the initiated packages, the United Arab Emirates (UAE) has implemented a countrywide disinfection application that includes entire sterilization of all public utilities, public transport, metro offerings, and roads. The UAE has also stepped up its efforts in trying out patients for COVID-19 through starting numerous power-thru centers throughout the country.

In addition to the disinfection program and force-through trying out facilities, the UAE, like many other international locations, had recourse to other mitigation techniques inclusive of building field hospitals, enforcing travel bans, canceling public sports and events, suspending places of worship and their facilities, calling for the postponement of social occasions, ultimate entertainment venues, final public parks and beaches, and installing thermal detection systems at the entrances of shops and public regions.

2.2 Blockchain Technology

People from all around the world are operating tough to find the best solutions concerning the improvement and checking out of vaccines, stopping the spread of contamination and short identification of viral carriers seeing that coronavirus is extraordinarily contagious. In fact, blockchain capability use instances in healthcare range thus to fulfill extraordinary necessities, which include facts sharing, protection, and data get admission to. different examples include blockchain platforms designed for clinical trials or precision medicine. inside the cutting-edge experience of epidemic management, blockchain is evolving as a vital technology answer in supplying a obvious, dependable, and low-price strategy to facilitate successful choice making, which could successfully bring about contributing to faster intervention during this disaster. Blockchain is now displaying enough opportunities to come to be an quintessential a part of combating against COVID-19 as it would permit green tracking and tracking solutions, ensure a obvious deliver chain of critical merchandise and donations, and secure bills. this is viable due to the fact blockchain contains a chronologically ordered listing of encrypted signatures, a relaxed allotted ledger containing permanent transaction data which can be shared through all contributors inside the network. moreover, adopting blockchains and public ledgers maximizes value financial savings by using removing intermediaries that cope with guide transactions. The blockchain platform consists of specifically three components, which can be information block, disbursed ledger, and consensus set of rules. each aspect is defined under as follows:

2.2.1 Data Block

It is able to be described as a series of blocks interconnecting each newly updated block to its previous block till it receives connected again to its genesis block to create a relaxed chain. This prevents any threat of modification as every block is strongly connected to the preceding one the usage of a hash label, which builds a robust hyperlink between blocks.

2.2.2 Distributed Ledger

It is also referred to as a database that facts and stores transactions generated via customers. every transaction carries a unique cryptographic signature decoupled with a timestamp, thereby making the ledger proof against

alterations. furthermore, this ledger is shared throughout all participants of the community concurrently so that customers are updated in actual time.

2.2.3 Consensus Algorithm

No entity should be able to control the system of transacting a block over the chain so that every block is managed by means of all participants who proportion identical rights to conquer protection troubles including double spending. that is performed thru the method known as consensus. From the blockchain's factor of view, the consensus technique establishes an contract amongst entities regarding the validation of every facts block. that is accomplished via nodes joining within the mining manner and competing with one another to confirm the block to get hold of a rate as a reward in go back for his or her mining attempt. for instance, Bitcoin makes use of a proof-of-work (PoW) algorithm to control its transactions, even as Ethereum uses proof-of-stake (PoS) algorithm. also, there are numerous different algorithms as properly, which includes the Byzantine faulty tolerant (BFT) set of rules.

Unlike conventional database systems, blockchain generation utilizes its inherent residences to make certain transparency, immutability, and accuracy in the course of data series and data control transactions. furthermore, blockchain permits two or greater events to interact without problems with each other in a digital environment and allows them to exchange cash within the absence of a government. in lots of aspects, blockchains transforming many industries by using allowing fee trade, openness, and agree with throughout business ecosystems. it is used in many industries along with power, law, tourism, supply chain, banking, and healthcare. It has proved to be useful inside the healthcare zone because it promises to beautify healthcare records privateness and at ease information control. As a result, it's far immensely appropriate for tackling coronavirus- related healthcare troubles.

III. BLOCKCHAIN BASED USE CASE

On this segment, we offer a comprehensive literature evaluate at the prominent blockchain-primarily based uses cases for preventing the COVID-19 pandemic. Blockchain generation can decorate the healthcare zone in numerous regions which might be affected by this outbreak, including enhancements to clinical trials, dealing with supply chain operations, tracking donations, and so on.

3.1 Clinical Trial Management

Every product should be very well tested to demonstrate its safety and efficiency and note viable facet effects in a scientific trial, to carry new medications and scientific devices into the marketplace. scientific trials specifically take location in four phases, out of which section III trials comprise the finest number of individuals or patients, making them difficult and useful resource worrying. For scientific trials to function efficaciously, they require a control device that is truthful and trans- figure. besides taking care of the considerable quantity of information

amassed from each segment, the clinical protocol should be value-talented, regulatory compliant, auditable, secure, fast, and obvious to all stakeholders in the community. the use of virtual technologies and innovations can assist make certain the safety and privateness of contributors at the same time as reducing trial timelines.

Blockchain technology can usefully resource researchers and clinicians in recording medical information in actual time as they come to be available. This improves accuracy, encourages facts sharing, and guarantees regulatory compliance. it may also tune and keep tally of who has accessed which a part of the datasets, as a consequence growing an audit path that improves privateness and information security.

Civitas, an app released through a Canadian startup that engages in blockchain solutions, assists diverse authorities' officials and neighborhood authorities in controlling the COVID-19 outbreak. This app may be beneficial in handling clinical trials associated with COVID-19 as it friends every body's identification with its corresponding blockchain facts anonymously without disclosing their identity. it may find out whether or not a person has left his domestic or not. that is vital as it facilitates in minimizing the unfold of this virus. similarly, it may permit docs to music the progress in their sufferers and display their signs for any facet consequences. In go back, these medical doctors can send them their report concerning the medication process this is to be accompanied.

3.2 Medical Supply Chain

The COVID-19 emergency has brought on massive interruptions across worldwide deliver chains. two primary factors play a vicious activity: several factories closed because of protection and hygienic issues, and there is an unheard of demand for specific merchandise PPE and medical components. Many users are forced to cozy sup-plies from unknown origins or excellent due to the improved call for. prolonged supply chains motive excessive obscurity, which makes it hard to calculate and plan supply. Blockchain is the first-rate alternative for deliver chains as it may connect all stakeholders into one supply chain network regularly occurring supply at the same time as showing transparency and being capable of securely wreck down fact's silos. therefore, massive numbers of the blockchain arrangements for the duration of the COVID-19 pandemic are in supply chain management. Blockchain quickens the validation procedure by using expelling third-birthday party delegates and innate delays in dealing with and processing operations. The benefits consist of quicker coping with and processing time, reduced costs, lower operational dangers, and faster settlements for all events covered. The Ve-Chain platform is making sure that new KN95 masks imported from China are credible and reliable whilst working inseparably with manufacturing workplaces and facilities. From codes to programs, materials, all obligations related to vaccine production are noted and stored in allocated ledgers.

3.3 User Privacy Protection

In these difficult times, the balance ought to be received among statistics collection and privacy assurance. Blockchain can be applied to collect and look at affected

person statistics extra productively and display patients' movements to make sure the necessary social distancing requirements at the same time as protecting their identity concurrently. there may be no focal energy, and customers are given control in their records in a blockchain platform. they can especially percentage facts that are massive for coronavirus relief efforts while ensuring their privacy and identity stays blanketed. in addition to this, governments and healthcare institutions can increase statistics series via coronavirus monitoring, even as clients can be guaran- teed that their records will now not be uncovered or shared. a group of privacy experts throughout Europe devised a blockchain- based framework for COVID-19 contract tracing making use of Bluetooth. moreover, German tech scale-up MYNXG has made a blockchain-primarily based association that uses cell phones at the same time as safeguarding consumer security.

3.4 Data Aggregation

To successfully respond to the pandemic, a key territory of opportunity is inside the collection, accumulation, and get entry to information vital for the monitoring of the contamination, interpreting traits, and administering research. Blockchain affords the opportunity of guaranteeing statistics accuracy by way of its functionality to confirm and keep immutable real-time data. The framework of Blockchain acts as a base for new growing research at the same time as permitting businesses and institutions to proportion their information with innovators, scientists, and researchers to test and include this data into new gadgets and answers. making use of a blockchain-fueled platform empowers compliance management, records proprietorship, and auditability to grant flexible sharing at some point of extraordinary managerial stages. MiPasa, international scale manipulates and correspondence gadget managed through blockchain innovation, which assists with accumulating, collating, and reading statistics about the virus's spread and containment, become released by means of WHO even as collaborating with large innovation agencies and governments. MiPasa is an asset that has expectancies to assist the public fitness officers, the clinical and commercial enterprise community, and people in preferred.

3.5 Contact Tracing

Contract tracing enables keep away from the spread of a deadly disease through seasoned-actively identifying, advising, and, in which vital, quarantining folks that are at a better danger than others. the usage of this tracing method is useful, and smartphones aid in making the machine greater effective most effective if privateness and other problems are addressed. Governments and healthcare corporations interact in contract-tracing activities to screen patients. however, the usage of blockchain at each step will increase the accuracy and reliability of information accumulated. Blockchain technology can monitor affected person actions and provide updates associated with affected regions in real time. furthermore, it can be used to discover virus-loose zones to tell the public approximately safe areas. understand that this information can be acquired from monitoring companies the use of a mixture of technology including AI and geographical facts structures (GIS). Blockchain can, therefore, offer sensible procedures to guard populations

from the unfold of the virus by way of complying with quarantine standards.

Coalition is a unfastened app within the united states of America that customers can screen themselves if they are sick. different users are notified of capability interactions with an inflamed man or woman and are encouraged to offer proper fitness comply with-up.

the answer makes use of Bluetooth-enabled cryptography generation to song conferences and generate nameless random IDs to defend the identification of the consumer with all statistics regionally stored on a consumer's phone. In Europe, Africa, and Asia, comparable answers had been explored. also, the public fitness Blockchain Consortium (PHBC) introduced the release of a blockchain for systematic tracking, continuous and adequate tracking in virus-free zones to ensure that an infected character does now not enter this place.

3.6 Donation Tracking

The pandemic scenario has offered extreme hardships to humanity. to alleviate the challenges, several philanthropists have donated products and financial useful resource, and the entire donation manner that contains of warehousing, logistics, and distribution can be stored in the blockchain. using this era, the donor can confirm the switch procedure and receipt of donated money exactly and transparently. consequently, blockchain will take away intermediaries, keep costs, reduce donation exploitation, and boost social brotherly love. Motivating donation practices enables to aid human beings facing medical or financial difficulties due to the unfold of infectious illnesses. Hyper chain is a blockchain-primarily based network that ambitions to counter the coronavirus outbreak through that specialize in uniquely monitoring donations. This platform assists governments and healthcare businesses within the donation system for infected sufferers. This community ensures the donation technique stays unchangeable, green, and traceable. It affords a obvious platform that lets in donors to reveal in which their finances have been used. through providing evidence of want and proof of receipt, the blockchain charity platform ensures that the donations attain intended groups directly without intermediaries.

3.7 Outbreak Tracking

Blockchain gets rid of the want for outsiders due to its decentralization characteristic, that may significantly lessen the occurrence of statistics amendment and fictitious news and increase the reliability of statistics for the general populace and experts in healthcare. Fraudulent statistics contributes to chaos and reasons monetary damage and psychological distress. therefore, storing information and statistics on a blockchain database prevents its modification and makes it traceable, thereby making it easier to keep away from fake information and data. Blockchain generation gives a suitable coronavirus monitoring platform as records treated thru such a community are reliable, accurate, tamper-unfastened, and transparent. consequently, governments can update better on the popularity of coronavirus pandemic for stepped forward planning and management, including forecasting the outbreak, setting apart possible territories, and tracking the spread of the infection. Acoer has created a Hash Log dashboard from an

ever-growing set of public data that lets in people to recognize the volume of infection spread and pattern over time. moreover, information collected from the CDC, WHO, and developments from social networking websites enables the Acoer Coronavirus Hash Log to make statistics visualization models related to clinical trial statistics.

On this paper, our number one focus is on leveraging smart contracts and oracles to validate statistics reporting, thereby pre- venting the unfold of false facts. This precise use case is important as there's a sudden surge in various social structures claiming incorrect information. therefore, there may be a want to authenticate and reveal records and information communicated publicly. additionally, it's miles critical to track the source of the message to discover customers who are engaged in spreading conspiracy theories, rumors, inflammatory comments, and pretend news. as a result, it is exceedingly endorsed to use a public blockchain platform to validate the messages as it enables all customers to digitally signal their message before it gets delivered to the blocks making it less difficult to identify the supply of data.

IV. BLOCKCHAIN BASED DATA TRACKING

We suggest a blockchain-based solution and device for tracking records applicable to COVID-19. The device connects decentralized programs (DApps), dashboards, smart con- tracts, oracles, and web feed resources within the equal decentralized Ethereum community, as illustrated. The proposed framework collects facts from diverse internet feed assets (WHO, CDC, IHME, etc.) via oracles.
The proposed gadget additives are defined under:

4.1 Ethereum Smart Contract

The second one-generation blockchain platform, inclusive of Ethereum, allows smart contracts that act as software program marketers to be deployed inside the blockchain community. smart con- tracts can robotically execute the terms of the contract and affirm credible transactions without interference from 1/3 parties. In our proposed solution, the blockchain system includes 3 smart contracts.

4.1.1 Registration Contract

This smart contract consists of statistics about web sources and any taking part stakeholders.

4.1.2 Reputation Contract

This smart contract deals with assigning a reputation rating for an oracle derived from the assessment of web resources used to retrieve records. the entire reputation score of an oracle consists of the credibility of the net supply along with the popularity rating a person has assigned to it. The popularity is, consequently, positively suffering from honest and professional web sites and negatively stricken by malicious ones. The reputation rating of an oracle relies upon on its trustworthiness. If the trustworthiness of an oracle is above the edge, its popularity score is calculated.

$$Cr(A) = \frac{\text{RepScore}(A) \times T}{4 \times \text{Adj}F}$$

Where in Cr(A) represents the whole popularity of an oracle wherein A is the address of the oracle. RepScore(A) is the reputation rating of the internet supply, and T represents the accept as true with- worthiness of the oracle, that is the distinction among the value reported with the aid of the oracle and the price computed by means of the smart contract, while AdjF is the adjusting factor, i.e., how harsh, or lenient we need to be with nodes reporting incorrect values.

however, if the trustworthiness of the oracle is under the edge, the popularity of an oracle is computed the use of

$$Cr(A) \quad \frac{\text{RepScore }(A) \times T}{4 \times (10 - \text{Adj}F)}$$

4.1.3 Aggregator Smart Contract

This smart contact is involved with retrieving the present day updates and sending them to front-stop users. it's going to get hold of updates most effective from credible oracles with a high reputation rating, whilst it drops updates from oracles with low ratings. The popularity ratings supplied for every oracle are then grouped into clusters. The cluster head can be determined both via taking a member of the cluster that is about in the center or considering the centroid of the values. as soon as the maximum reliable cluster is determined, the updates of the latter are dispatched to the front-stop customers via the DApps and/or dashboards.

4.2 Trusted Oracle Network

Oracles act as third-party services that feed smart contracts with outside facts as they're not able to fetch outside information on their personal. records feeds in net APIs are typically no longer deterministic like blockchain and smart contracts. therefore, oracles act as a bridge this is able to processing outside and non-deterministic records into a layout that can be understood and finished via smart contracts. It must be referred to that obtaining statistics from a unmarried oracle isn't reliable; consequently, multiple oracles are needed to report news and data feed to the smart contract. Then, smart contract validates and tests the stated facts from a couple of oracles to verify the trustworthiness of the reported facts. This removes the need for trusting handiest one source, averting the incidence of a single factor of failure.

4.3 Message Sequence Diagram

A sequence diagram shows the interactions among distinctive stakeholders while concurrently displaying diverse activities that are brought on inside the series of capabilities which are caused inside the smart settlement. each player in the community holds an Ethereum cope with that permits them to engage with each different by way of calling capabilities inside the smart contract. illustrates the sequence go with the flow between different stakeholders, from extracting statistics from internet assets to presenting the today's updates to DApps or dashboards. to begin with, the oracle resources are registered in the registration smart contract to keep statistics about our stakeholders. This takes place by executing the function known as *RegisterOracle*

*(Address).*Then, the aggregator smart con- tract could invoke the function *computeReputation(Address)* to check the trustworthiness, credibility, and popularity of registered oracles. in a while, the oracles extract data from the registered web assets through executing the function *inputOracle(infect, recover, death).* as soon as the oracles extract the specified attributes: variety of recoveries, infections, and deaths, the extracted records go to the aggregator smart contract. The contract then approves the maximum legit cluster of data as a way to be provided to the DApp front-give up users by invoking *CalculateStatistics()* function. by those apps, front-stop customers would be capable of get admission to real-time data about the brand new recoveries, infections, and deaths in a depended on and dependable manner.

V. IMPLEMENTATION

We present and discuss the algorithms for implementing the blockchain-based totally COVID-19 tracking gadget that captures the running ideas of our proposed answer main to the improvement of the smart contract. The smart contracts have been written in Solidity, that's a broadly used language for Ethereum smart contracts. Compilation and execution of the contract have been accomplished the use of Remix IDE, that's a browser-primarily based compiler with an embedded debugger used for alerting and alarming the person with errors notifications and warnings consequently.

firstly, oracles are assigned Ethereum addresses as a way to interact with the smart contracts as they act as a gate-manner among the blockchain platform and external records. This datum will incorporate of the facts related to the range of inflamed and recovered cases and deaths obtained from dependable assets. This registration system is handled by way of the registration smart contract.

The aggregator smart contract has the extra capability of the registration smart settlement this is essential to register oracles. first off, oracles are assigned Ethereum addresses with a purpose to interact with the smart contract as they act as a gateway among the blockchain platform and extern al information. This datum will comprise of the data related to the number of inflamed and recovered cases and deaths received from dependable assets.

algorithm 1 describes how handiest sincere assets are used by registering oracles beneath the characteristic registerOra- cle() to check whether or not the cope with is registered or now not. If the oracle is not registered, then this characteristic is liable for registering the oracles through appending its Ethereum address to the list of the oracles of various resources. After the manner of registration, the oracle is then given an preliminary credibility score of eighty, which can later vary based totally on the facts furnished with the aid of this oracle. After the a success registration of oracles, they are now eligible to feed the smart contract with facts extracted from online assets along with IHME and CDC the use of the oraclInput() feature, as shown in algorithm 1. Then, the process of records aggregation starts offevolved by way of incrementing the inflamed, recovered, and the lifeless counts corresponding to that oracle.

that is followed through updating the oracle records whilst simultaneously triggering activities to notify stakeholders

with the cutting-edge updates.

Algorithm 1: Oracle Registration and data input

Input: *oracleAddress, infected, recovered, dead*

1 *oracleAddress* is the Ethereum Address of oracle that update data to smart contract.
2 *infected, recovered,* and *dead* patients since last update.
3 Verify if the oracle exists
4 **if** *oracle already exists* **then**
5 | Oracle is allowed to transfer data
6 **else**
7 | Initialize oracle information.
8 | Append the oracle to list of oracles
9 **end**
   /* Oracle Input   */
10 Increment number of infected, recovered, and dead as reported by this oracle.
11 Update the oracle records.
12 Announce the latest oracle updates using an event.

Then, the submitted facts are processed and grouped into clusters, as proven in algorithm 2. it might ensure that facts submitted is tested with the aid of the use of a loop to go over each registered oracle. The clustering manner takes place by means of comparing the enter information with the statistics that already exists in the clusters. If the brand new statistics are like one of the avail- capable clusters, then the oracle is added to that cluster for this reason else a new cluster is created. Then, the proper cluster is chosen by using choosing the cluster with the highest variety of oracles. It need to be referred to that the credibility of oracles is also taken into consideration when choosing the cluster. but, for this paper, the credibility value turned into fixed for simplification. subsequently, the centroid of the truthful cluster might be discovered and used to update the ledger.

Algorithm 2: Update Coronavirus Statistics

1 *clusters* include similar statistics provided by different clusters.
2 *averageInfected, averageRecovered, averageDead* are the average statisics as recorded by all oracles.
   foreach *oracle* **do**
3 | **if** *oracle input is similar to one of the available clusters* **then**
4 | Append the oracle to the appropriate cluster. Append the reputation score of the cluster.
5 | **else**
6 | Create a new cluster for the current oracle.
7 | **end**
8 **end**
9 Obtain the most trustworthy cluster. Statistics are updated to the average value as provied by memebers of this cluster.

Once the smart contract has aggregated the input from all oracles, the reputation of the oracles is to be updated. The input of these oracles is as compared to the computed values of the infected, recovered, and deceased instances. As proven in algorithm 3, the trustworthiness factor is computed, that is contemplated inside the alternate of the popularity scores of the oracle. If the oracle is within the most professional cluster, it's far taken into consideration a credible source of input, and its recognition will increase. After many iterations, the most reliable oracles are given more weight

while computing the final information.

```
Algorithm 3: Update oracle reputation scores
Input: oracleAddress
1  oracleAddress is the Ethereum Address of the oracle
   whose reputation is being computed.
2  Get latest update reported by the oracle.
3  Compare input of oracle with the value calculated by
   aggregator SC to get the trustworthiness factor.
4  if trustworthiness factor > threshold then
5  |    Oracle reputation is incremented as shown in
   |       Equation 1.
6  else
7  |    Oracle reputation is decremented as shown in
   |       Equation 2.
8  end
9  Update oracle records.
```

The code was then compiled correctly and tested within the Remix environment. It was located that the functions had been performed sequentially as expected. furthermore, the code established that most effective registered oracles were allowed to interact with the clever agreement. We fed the information with statistics wherein the code picked out the most straightforward cluster primarily based on the algorithm. This reinforces that the developed code works as meant. the total clever agreement code can be discovered in the GitHub repository.

VI.   TESTING AND VALIDATION

The proposed solution was deployed and examined on a virtual check Ethereum community using Remix IDE. The smart agreement code turned into implemented and debugged. All feature calls can be viewed within the console to verify the functionality of the techniques, the output, and the fee of execution.

To carry out the capability checking out, the registration con- tract was first deployed. The registration clever agreement proprietor registered several oracles that report statistics approximately the wide variety of instances. every of those oracles has a exclusive Ethereum cope with used from the to be had addresses in the IDE. The popularity score is initialized robotically via the smart agreement and related to the cope with of the oracle. Oracles can handiest be registered by way of the smart agreement proprietor for protection motives.

VII.   DISUCCION AND ANALYSIS

Our proposed blockchain-primarily based answer for monitoring the COVID-19 pandemic captures the principal operations required for dynamically monitoring the transmission and the cutting-edge range of inflamed, recovered, and deaths. in this phase, we speak the price and protection analysis of our proposed device. We additionally spotlight the demanding situations and destiny instructions for enforcing the proposed system.

VIII.   FUTURE DIRECTION

Overall, our proposed solution is regularly occurring

enough that it is able to be adapted to cater to statistics series and file information on other infectious illnesses, including Malaria, HIV, and TB. this is possible as blockchain encourages the sharing and reporting of statistics amongst stakeholders in a network.

The seasoned- posed answer can be used to streamline communique between sufferers and healthcare professionals. it may join all research and healthcare communities in the same network to apply and proportion a depended on comfortable database that is tamper evidence. moreover, the oracles inside the network will be rewarded by growing their credibility to encourage them to file correct data. but, it must be cited that each one relevant stakeholders should be involved in imposing the proposed answer in order that it's miles sustainable, green, and agree with- worth. This interplay is specifically critical in regions with underserved communities.

IX.   CONCLUSION

In this paper, we proposed and evaluated a blockchain-based totally tracking machine for validating the COVID-19 records from various resources to mitigate the spread of falsified or modified facts. Our proposed blockchain-based solution promotes agree with, transparency, traceability and streamlines the communique between stakeholders in the community. Our proposed answer leverages Ethereum clever contracts and oracles and demonstrates the important utility of blockchain era for COVID-19. The advanced device might update the DApps and dashboards with real-time information as they come to be available, related to the wide variety of showed instances, deaths, and recoveries. The presented system architecture, collection diagram, and algorithms can be effortlessly generalized for tracking various different infectious sicknesses. Our provided solution addresses the problems confronted within the cutting-edge pan- demic disaster, together with miscommunication, information manipulation, and single point of failure. moreover, it mitigates malicious sports because of its inherent cryptography protection functions of blockchain technology. The smart agreement code is made publicly to be had in GitHub. We gift an in depth value analysis to compute the transaction expenses incurred by means of stakeholders while interacting with the smart contract. moreover, we present security evaluation contracting on integrity, duty, authorization, non-repudiation, and resilience to common kinds of cyberattacks, such as DDoS attacks. As future work, we goal to expand the clever agreement functionalities and develop DApps to allow members to interact with Ethereum clever contracts seamlessly.

X.   REFERENCES

[1] WHO. Rolling updates on coronavirus disease (COVID-19). World Health Organization. https://www.who.int/emergencies/diseases/ novel-coronavirus-2019/events-as-they-happen. Accessed 25 May 2020

[2] Ramsay, G.: Japanese PM and IOC chief agree to postpone 2020Olympics until 2021. CNN, 24 March 2020. https://edition.cnn.com/2020/03/24/sport/olympics-postponement-tokyo-2020-spt- intl/index.html. Accessed 25 May 2020

[3] Houston, L.; Probst Y.; Humphries, A.: Measuring data quality through a source data verification audit in clinical research

setting.Stud Health Technol Inform (2015)

[4] Bischoff, P.: COVID-19 App Tracker: Is privacy being sacrificed in a bid to combat the virus?. CompariTech, 20 April 2020. https://www.comparitech.com/blog/vpn-privacy/coronavirus-apps/. Accessed 25 May 2020

[5] Warner, K.; Nowais, S.A.: Coronavirus: Doctors urge public tohelp track COVID-19 cases with tracing app. The National, 28April 2020. https://www.thenational.ae/uae/health/coronavirus-doctors-urge-public-to-help-track-covid-19-cases-with-tracing- app-1.1012267. Accessed 25 May 2020

[6] Tangermann, V.: Hackers are using coronavirus maps to spreadmalware. World Economic Forum, 14 March 2020. https://www.weforum.org/agenda/2020/03/hackers-are-using-coronavirus- maps-to-spread-malware?fbclid=IwAR06Xux96s2GTy_-Ttew1Cuy96YV4ng9Z4eGd0kFVa-a_QbapumxgFO6DmU. Accessed25 May 2020

[7] Villas-Boas, A.: A fake coronavirus tracking app is actually ransomware that threatens to leak social media accounts and deletea phone's storage unless a victim pays $100 in bitcoin. Busi- ness Insider, 16 March 2020. https://www.businessinsider.com/ coronavirus-fake-app-ransomware-malware-bitcoin-android- demands-ransom-domaintools-2020-3. Accessed 25 May 2020

[8] Tesini, B.L.: MSD Manual. May 2020. https://www.msdmanuals.com/professional/infectious-diseases/respiratory-viruses/ coronaviruses-and-acute-respiratory-syndromes-covid-19,-mers,- and-sars#v47572273. Accessed 3 June 2020

[9] Readfearn, G.: How did coronavirus start and where did it come from? Was it really Wuhan's animal market?. The Guardian,28 April 2020. https://www.theguardian.com/world/2020/apr/28/how-did-the-coronavirus-start-where-did-it-come-from-how-did- it-spread-humans-was-it-really-bats-pangolins-wuhan-animal- market. Accessed 3 June 2020

[10] Cennimo, D.J.: Coronavirus Disease 2019 (COVID-19). Med-Scape, 1 June 2020. https://emedicine.medscape.com/article/250 0114-overview#a9. Accessed 3 June 2020

[11] Coronavirus disease 2019 (COVID-19). MayoClinic, 22 May 2020. https://www.mayoclinic.org/diseases-conditions/coronavirus/ symptoms-causes/syc-20479963. Accessed 3 June 2020

[12] COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE). Johns Hopkins University, 2020. https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6. Accessed 3 June 2020

[13] Coronavirus Disease 2019 (COVID-19). CDC Center for Dis- ease Control and Prevention, May 2020. https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html. Accessed June 2020

[14] Coronavirus disease (COVID-19): Prevention and risks. Gov- ernment of Canada, 29 May 2020. https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/prevention-risks.html. Accessed 3 June 2020

[15] How to Protect Yourself & Others. CDC Center of Disease Control and Prevention, 24 April 2020. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html. Accessed 4 June2020

[16] Sandford, A.: Coronavirus: Half of humanity now on lockdown as 90 countries call for confinement. Euronews, 3 April 2020. https://www.euronews.com/2020/04/02/coronavirus-in-europe- spain-s-death-toll-hits-10-000-after-record-950-new-deaths-in-2 4-hou. Accessed 4 June 2020

[17] Wright, R.: The world's largest coronavirus lockdown is having a dramatic impact on pollution in India. CNN, 1 April 2020. https://edition.cnn.com/2020/03/31/asia/coronavirus-lockdown-impact-pollution-india-intl-hnk/index.html. Accessed 4June 2020

[18] Chico Harlan, S.P.: Italy extends coronavirus lockdown to entire country, imposing restrictions on 60 million people. Washington Post, 10 March 2020. Chico Harlan and [Accessed 4 June 2020

[19] Carmen, R.S.; Reinhart, M.: How can we prevent a COVID-19 food crisis? World Economic Forum, May 2020. https://www.weforum.org/agenda/2020/05/preventing-a-covid-19-food-crisis/. Accessed4 June 2020

[20] A. F. et al.: Simulating SARS-CoV-2 epidemics by region-specific variables and modeling contact tracing App containment. MedRxiv (2020)

[21] M. I.,. M. B.,. S. D.,. L. F. R. F. Chiara Farronato, "Harvard Business Review," 15 July 2020. Chiara Farronato, Marco Iansiti, Marcin Bartosiak, Stefano Denicolai, Luca Ferretti and Roberto Fontana

MoHAP: Ministry of Health and Prevention. 25 April 2020. https://www.mohap.gov.ae/en/MediaCenter/News/Pages/2385.aspx