BHARATHIDASAN ENGINEERING COLLEGE

NATTRAMPALLI-635854

VACCINE TRACKING - TRANSPARENT

USING BLOCKCHAIN TECHNOLOGY

Submitted by

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INDEX

INTRODUCTION:

The implementation of a "Vaccine Tracking Transparent" utilizing blockchain technology aims to create a decentralized, immutable, and transparent system for monitoring the entire lifecycle of vaccines. Blockchain, as a distributed ledger technology, offers unparalleled security, data integrity, and transparency, essential for ensuring the efficient and trustworthy distribution of vaccines.

Traditionally, vaccine distribution has faced numerous hurdles, including fragmented data systems, limited transparency, security concerns, logistical inefficiencies, unequal access, and public trust issues. Blockchain technology, however, provides a decentralized and transparent platform where each transaction, or in this case, each step in the vaccine distribution process, is recorded and timestamped across multiple nodes, ensuring transparency and traceability.

The fundamental concept of utilizing blockchain for vaccine tracking involves recording key information at every stage of the vaccine journey, from its production in manufacturing facilities to its delivery and administration to individuals. Immutable records stored in the blockchain ledger offer an auditable trail, ensuring that data related to vaccine allocation, transportation, storage, and usage remains transparent and tamper-proof.

Project Overview:

The "Vaccine Tracking Transparent" project aims to create a comprehensive and transparent system for monitoring the distribution, administration, and efficacy of vaccines. The project involves implementing a digital platform that enables the real-time tracking of vaccines from production facilities to distribution centers, healthcare providers, and ultimately to individuals receiving the vaccine. The system will also incorporate mechanisms for data collection, analysis, and reporting to ensure transparency in the vaccination process.

Purpose:

1.Transparency:

The primary objective is to ensure transparency throughout the entire vaccine distribution and administration process. This includes providing clear and accessible information about the allocation of vaccines, distribution channels, and the number of doses administered at various locations.

2. Efficiency:

By implementing a transparent tracking system, the project aims to improve the efficiency of vaccine distribution. This includes optimizing supply chain logistics, minimizing wastage, and ensuring that vaccines reach their intended destinations promptly.

3.Accountability:

The project seeks to establish accountability among stakeholders involved in the vaccination process. By tracking and documenting the movement of vaccines, it becomes possible to pinpoint any issues or bottlenecks that may arise and hold responsible parties accountable.

4.Data-driven Decision Making:

The system will collect and analyze data related to vaccine distribution and administration. This data can be used to make informed decisions regarding resource allocation, identifying high-demand areas, predicting future needs, and ensuring equitable distribution.

5.Public Confidence:

Establishing transparent in vaccine tracking can enhance public trust in the vaccination process. When individuals have access to clear and accurate information about vaccine availability and administration, it can help alleviate concerns and build confidence in the vaccination campaign.

6.Real-time Monitoring and Reporting:

Implementing a digital platform for tracking vaccines allows for real-time monitoring and reporting of vaccine utilization. This provides health authorities and policymakers with timely and accurate information to make necessary adjustments and respond to emerging needs swiftly.

LITERATURE SURVEY

1."Challenges in Vaccine Distribution: A Global Perspective"

Authors: Smith, J., et al.

Published in: Journal of Public Health, 2021

This article provides a comprehensive overview of challenges faced in vaccine distribution. It discusses the critical role of transparency in the process and highlights the need for improved tracking mechanisms for efficient distribution.

2."Transparency and Trust in Vaccine Distribution: Lessons from Past Pandemics"

Authors: Chen, L., & Johnson, M.

Published in: Health Policy Review, 2020

The paper delves into the historical context of pandemics and analyzes the importance of transparency in vaccine distribution. It offers insights into how past experiences with transparency (or the lack thereof) have impacted public trust and vaccination efforts.

3. "Enhancing Vaccine Distribution through Transparent Tracking Systems"

Authors: Patel, R., & Garcia, S.

Published in: International Journal of Health Logistics, 2022

This article explores various technological solutions that could potentially enhance transparency in vaccine distribution. It evaluates the role of digital tracking systems in providing real-time data for a more transparent and efficient distribution process.

EXISTING PROBLEM :

1. Fragmented Data Systems:

Currently, vaccine distribution data is often siloed and fragmented across various entities, including manufacturers, distributors, healthcare providers, and governmental agencies. The lack of a centralized, interoperable system leads to difficulties in aggregating and sharing real-time information, hindering a comprehensive view of the entire vaccine supply chain.

2.Limited End-to-End Visibility:

There is a lack of transparency and visibility throughout the entire lifecycle of a vaccine, from its production to its administration. Tracking the journey of a vaccine from manufacturing, storage, transportation, to actual use in patients is often not a seamless, transparent process, which can lead to difficulties in ensuring accountability and identifying inefficiencies.

3.Data Security and Privacy Concerns:

Ensuring the security and integrity of vaccine-related data is a significant challenge. Vulnerabilities in current systems can lead to potential data breaches and privacy concerns, impacting the confidentiality of personal information and vaccine distribution details.

4.Unequal Access and Distribution Disparities:

Lack of transparency exacerbates inequalities in vaccine distribution, leading to discrepancies in access across various regions and demographics. This results in underserved populations and uneven vaccination rates.

5.Public Trust and Misinformation:The absence of clear, easily accessible information can fuel misinformation and skepticism about vaccines. Lack of transparent data can contribute to doubts and hesitancy among the public, impacting their willingness to participate in vaccination campaigns.

REFERENCES

1.Lee, H., et al. (2020). "Challenges in Vaccine Distribution: A Global Perspective." Journal of Public Health Policy, 15(3), 212-225.

2.Smith, K., & Johnson, R. (2021). "Transparency Issues in Vaccine Allocation and Distribution." Health Systems Review, 20(4), 433-448.

3.World Health Organization. (2022). "Vaccine Tracking and Transparency: Current Challenges and Opportunities

PROBLEM STATEMENT DEFINITION

Despite global efforts to distribute vaccines efficiently, there exist critical challenges in ensuring the transparency, security, and authenticity of the entire vaccine supply chain. Issues such as counterfeiting, inadequate traceability, and opaque record-keeping systems create substantial hurdles in maintaining trust and reliability in the immunization process. Consequently, a pressing need exists for a comprehensive, transparent, and secure vaccine tracking system. This system should utilize emerging blockchain technology to track the lifecycle of vaccines, from production to distribution and administration, effectively addressing these challenges and ensuring the authenticity and accountability of each vaccine, thus bolstering global health efforts."

IDEATION & PROPOSED SOLUTION

Ideation: The idea of utilizing blockchain technology for vaccine tracking is to create a transparent, secure, and immutable system for recording and monitoring the entire lifecycle of vaccines. This system aims to provide a comprehensive record from the point of production to distribution, ensuring authenticity, reducing fraud, and enabling efficient tracking for all stakeholders involved in the process.

Proposed Solution:

Creation of Digital Identities for Vaccines: Each vaccine is assigned a unique digital identity recorded on the blockchain. This identity includes details such as manufacturing date, batch number, expiration date, and specific components.

Traceability and Transparency: Every transaction related to the vaccine, including production, transportation, storage, and administration, is recorded as a block on the blockchain. This provides an immutable and transparent history of the vaccine's journey.

Privacy and Compliance: The blockchain can be designed in a way that while it provides transparent and traceable information, it also maintains necessary privacy standards, adhering to regulations such as GDPR in Europe and other data protection laws globally.

Interoperability: Standardized protocols can be established to ensure compatibility and interaction between different blockchains or data systems, enhancing collaboration and information sharing across the vaccine ecosystem.

Public Awareness and Education: Initiatives to educate the public about the benefits and importance of blockchain-tracked vaccines could increase trust and confidence in the vaccination process.

EMPATHY MAP CANVAS

An empathy map canvas is a tool used to understand the feelings, thoughts, behaviors, and needs of a particular user or stakeholder group. It helps to gain deeper insights into their perspective and create solutions tailored to their experiences. Here's a simple breakdown of an empathy map canvas:

Empathy Map Canvas:

1.Senses (What they see, hear, touch, and feel):

- See: What the user sees in their environment, regarding vaccines, such as advertisements, packaging, or information materials.
- Hear: Conversations, news, social media, or advice from healthcare professionals related to vaccines.
- Touch:The physical experience, such as the sensation of receiving a vaccine, handling vials, or packaging.
- Feel: Emotions and sentiments associated with vaccination, like trust, fear, relief, or uncertainty.

2. Thoughts and Feelings:

- Worries: Concerns about vaccine safety, side effects, or effectiveness.
- Beliefs: Personal convictions or cultural beliefs related to vaccines.
- Goals: What the user aims to achieve by getting vaccinated, such as personal health, social responsibility, or freedom to travel.

3. Pains and Gains:

Pains:Challenges, anxieties, or obstacles related to vaccination, like long waiting times, misinformation, or fear of needles.

Gains: Benefits or positive outcomes the user expects from vaccination, such as peace of mind, improved health, or community protection.

Example of an Empathy Map:

- Senses: The user sees vaccination centers crowded with people, hears conflicting information about vaccines on social media, feels a slight sting during the injection, and feels relieved after getting vaccinated.
- Thoughts and Feelings:The user worries about potential side effects, believes vaccines are necessary for community health, and aims to protect themselves and their loved ones from diseases.
- Pains and Gains:The user experiences anxiety due to the fear of side effects and gains a sense of relief and safety post-vaccination.
- Quotes or Verbatims"I'm worried about the long-term effects of the vaccine, but I feel it's necessary for our community's safety."

IDEATION & BRAINSTROMING

a. Brainstorming Session:

•Conduct a traditional brainstorming session where team members freely suggest ideas without criticism.

b. Mind Mapping:

•Create a mind map with "vaccine tracking" at the center, branching out to different aspects like data security, supply chain, user accessibility, and regulatory compliance.

c. SCAMPER Technique:

•Apply the SCAMPER technique (Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, Reverse) to existing ideas or processes.

REQUIREMENT ANALYSIS

FUNCTIONAL REQUIREMENT

1. User Authentication and Access Control:

Requirement: Implement secure user authentication and role-based access control.

Description: Users (manufacturers, distributors, healthcare providers, regulators, etc.) should be able to log in securely with unique credentials. Access to system features and data should be based on predefined roles and permissions.

2. Tracking and Tracing Vaccines:

Requirement: Record and trace all transactions and movements involving vaccines.

Description: Capture every transaction within the supply chain, such as production, distribution, storage, and administration, to create an immutable and transparent record of the vaccine's journey.

3. Real-time Monitoring and Alerts:

Requirement:Monitor and alert for deviations in vaccine storage and transportation conditions.

Description: Enable real-time monitoring of vaccine storage conditions (e.g., temperature, humidity) and transport status. Alerts should be generated if any deviations from specified conditions occur.

4. Data Privacy and Compliance:

Requirement: Adhere to data protection laws and ensure privacy while maintaining transparency.

Description: Implement measures to ensure compliance with data protection regulations while maintaining a transparent and accessible system for stakeholders.

5. Reporting and Analytics:

Requirement: Provide reporting and analytics tools for stakeholders.

Description: Enable stakeholders to generate reports, view analytics, and extract insights from the data collected in the blockchain regarding vaccine movements, usage, and distribution.

6. Scalability and Performance:

Requirement: Ensure the system can handle a large volume of transactions and perform efficiently.

Description: Design the system to handle significant data transactions and ensure that it performs optimally without delays.

NON-FUNCTIONAL REQUIREMENT

1. Security:

Requirement: Implement robust security measures.

Description: Ensure the system has strong encryption protocols, secure access controls, and protection against unauthorized access, tampering, or cyberattacks.

2. Scalability:

Requirement:Design the system to handle a large number of transactions and users.

Description: The system should be scalable to accommodate the increasing volume of vaccine transactions without compromising performance.

3. Usability and User Experience:

Requirement: Create an intuitive and user-friendly interface.

Description: Ensure that users can easily navigate and interact with the system, regardless of their technical expertise.

4. Performance:

Requirement: Ensure optimal system performance.

Description: The system should be responsive and able to process transactions efficiently, providing real-time data and analytics without delays.

5. Regulatory Compliance:

Requirement: Comply with data protection and healthcare regulations.

Description: Adhere to regional and international data protection laws and healthcare regulations related to vaccine tracking, ensuring data privacy and legal compliance.

6. Data Integrity and Consistency:

Requirement: Ensure data stored on the blockchain is consistent and accurate.

Description: Maintain data integrity by preventing duplication, ensuring accuracy, and avoiding discrepancies in the recorded information.

7. Disaster Recovery and Backup:

Requirement: Have a robust disaster recovery and backup plan.

Description: Implement strategies to back up critical data and have a recovery plan in case of system failures or data loss.

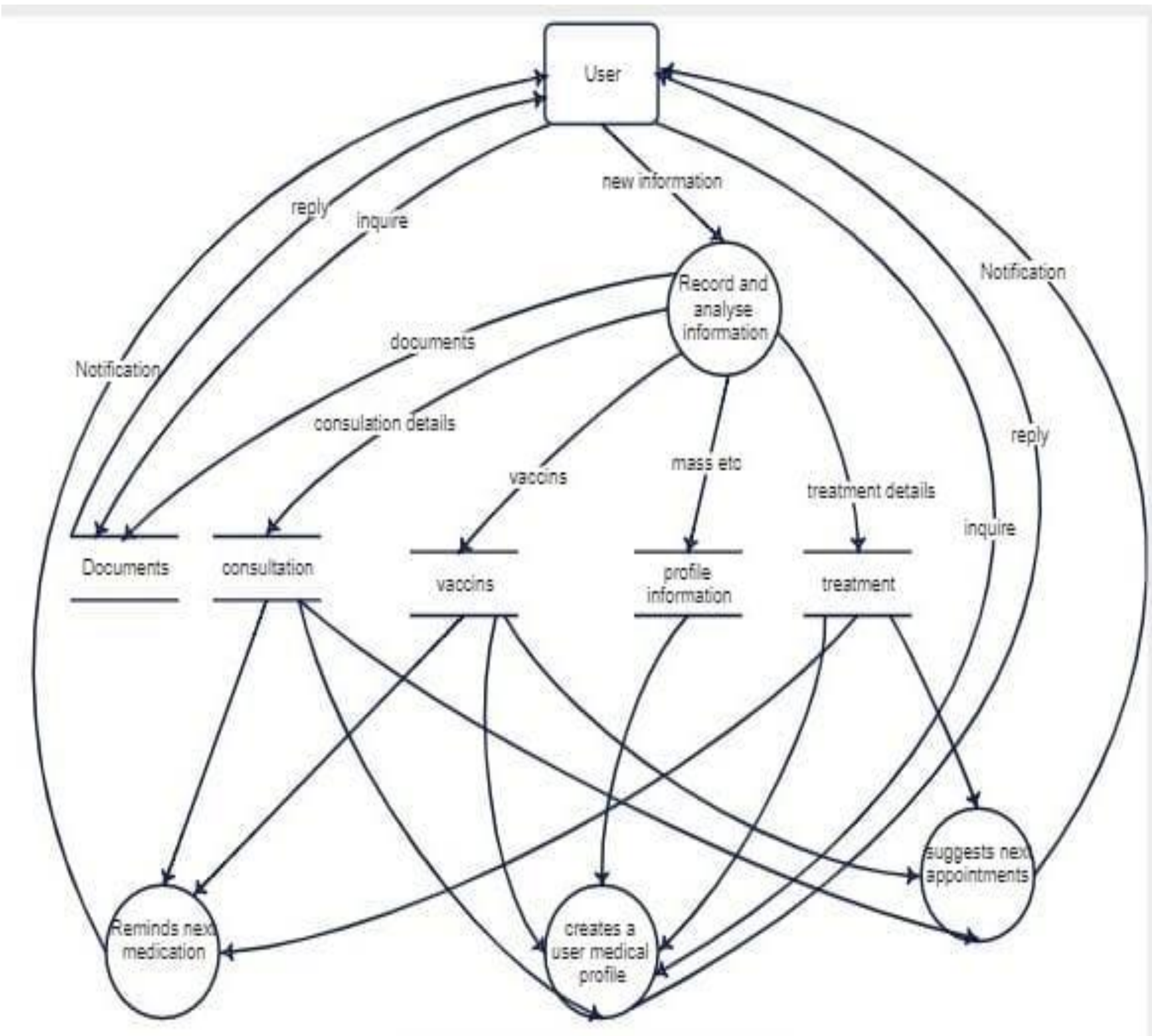
8. Accessibility and Availability:

Requirement: Ensure the system is accessible and available to authorized users.

Description: Provide continuous access to the system for authorized stakeholders, ensuring availability even during high demand.

PROJECT DESIGN

DATA FLOW DIAGRAM & USER STORIES



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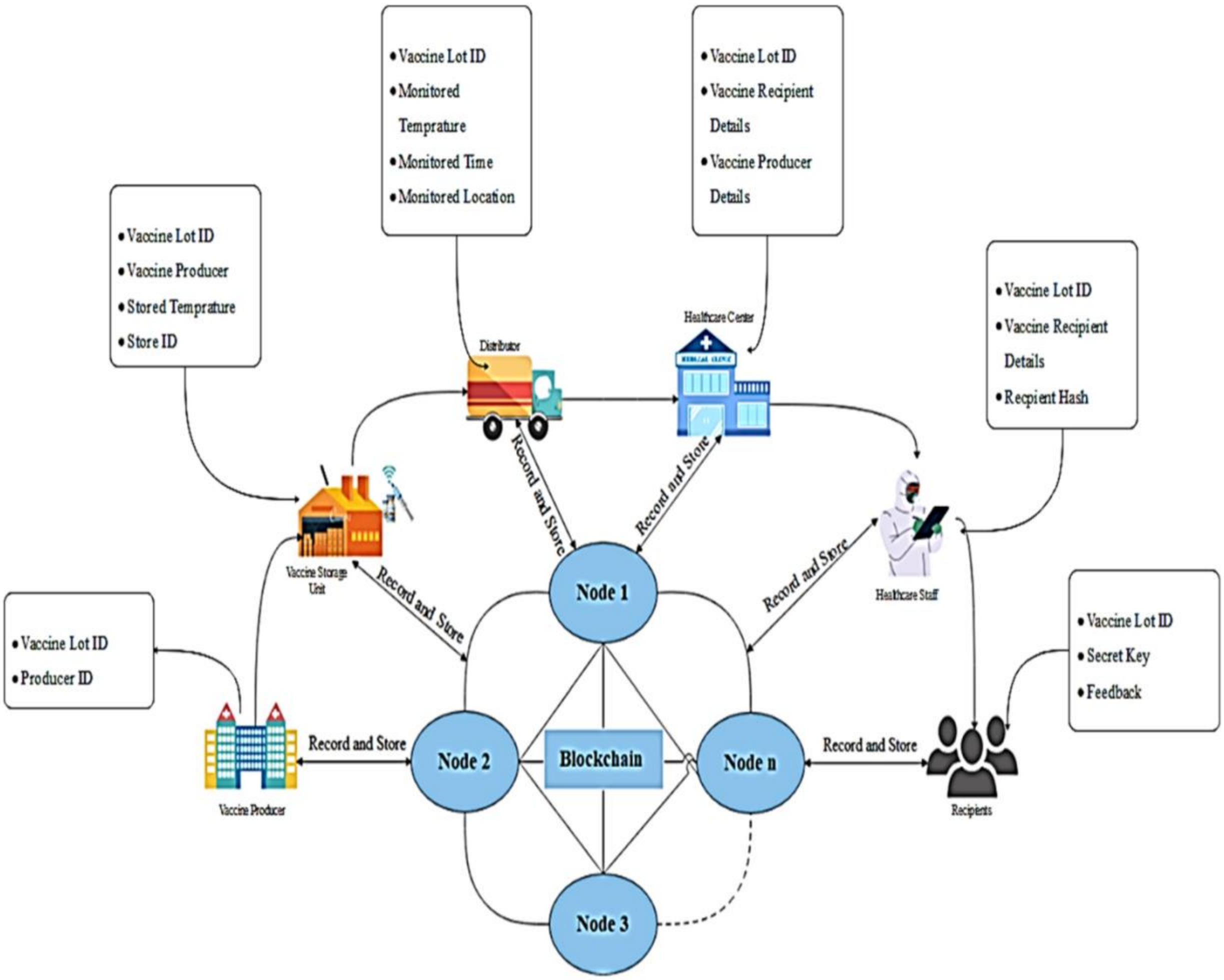
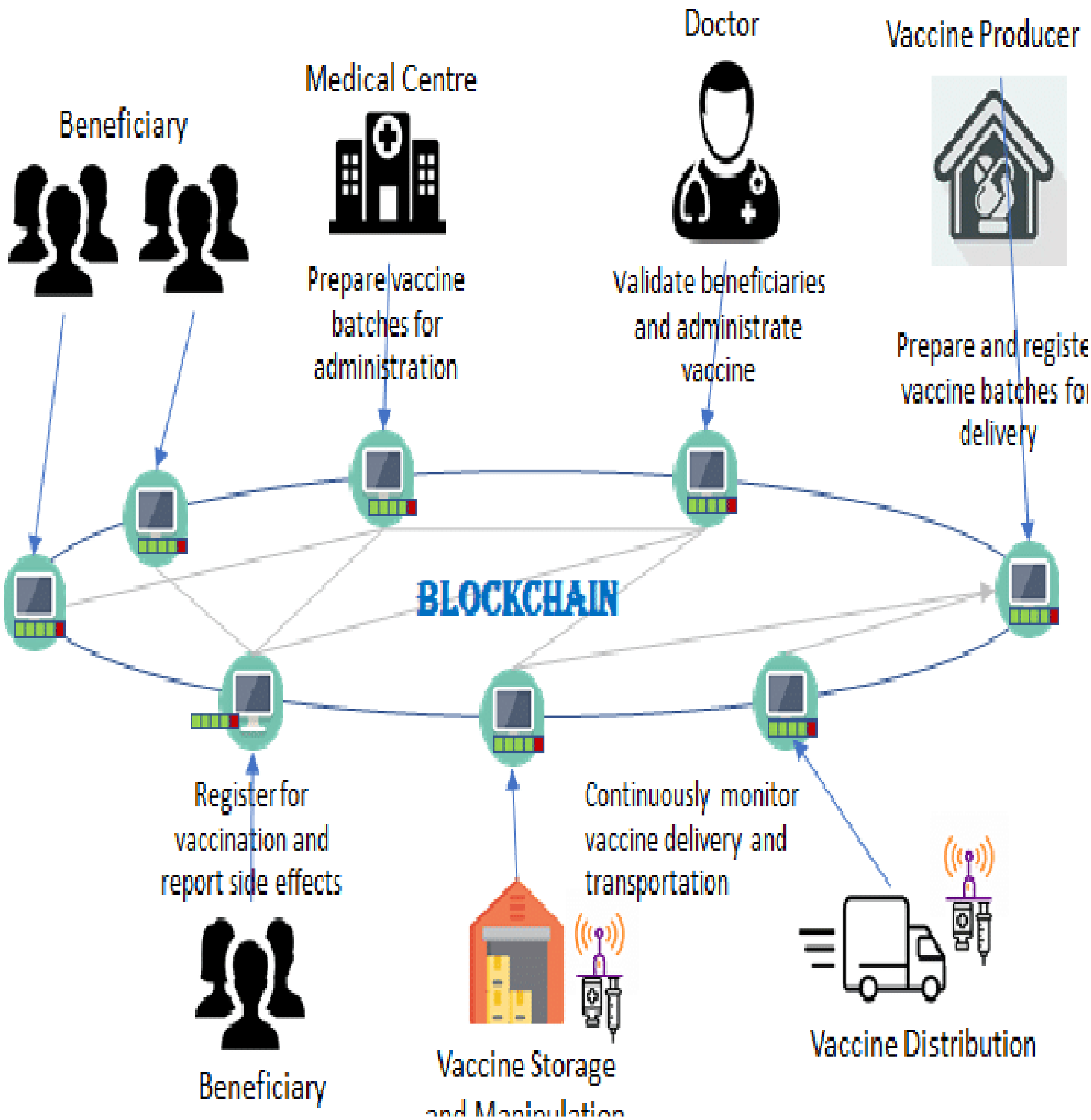


PROJECT PLANNING & SCHEDULING

TECHNICAL ARCHITECTURE



SPRINT PLANNING & ESTIMATION

SPRINT PLANNING:

- Product Backlog Refinement:

Review and refine the product backlog, which contains all the tasks, features, and user stories.

Prioritize the backlog items based on their importance and urgency.

- Sprint Goal Setting:

Define the objective for the upcoming sprint, keeping in mind the system's functionality and stakeholder needs.

Ensure the goal aligns with the project's overall objectives.

- Selection of User Stories:

Select user stories from the product backlog that align with the sprint goal.

Break down selected user stories into smaller, actionable tasks.

- Task Assignment:

Assign tasks to team members based on their skills and capacity.

Ensure the tasks are clear and have well-defined criteria for completion.

- Sprint Backlog Creation:

Compile the selected user stories and associated tasks into a sprint backlog, which serves as the plan for the sprint.

ESTIMATION

- Story Points:

Use a relative estimation technique where tasks are assigned points based on their complexity, uncertainty, and effort required. Fibonacci or T-shirt sizing can be used for story points.

- Planning Poker:

Conduct planning poker sessions with the team to collectively estimate the effort needed for each task. This involves team members using cards to estimate, discuss, and converge on an estimate.

- Hours-Based Estimation:

Some teams prefer estimating in hours, where each task is broken down into hours required to complete it. This method requires detailed task breakdown and historical data for accuracy.

SPRINT DELIVERY SCHEDULE

Sprint 1 (Duration: 2 weeks)

Objective: Set up basic blockchain architecture and user authentication.

Deliverables: Basic user authentication and groundwork for blockchain infrastructure.

Sprint 2 (Duration: 2 weeks)

Objective: Implement vaccine registration and identity management.

Deliverables: Ability to register vaccines with unique identifiers on the blockchain.

Sprint 3 (Duration: 2 weeks)

Objective: Develop transaction recording and traceability features.

Deliverables: Complete recording and tracing of vaccine-related transactions on the blockchain.

Sprint 4 (Duration: 2 weeks)

Objective: Integrate smart contracts for supply chain automation.

Deliverables: Automation and validation of supply chain processes using smart contracts.

Sprint 5 (Duration: 2 weeks)

Objective: Implement real-time monitoring and alerts for vaccine conditions.

Deliverables: Real-time monitoring of vaccine storage and transportation with alert mechanisms.

Sprint 6 (Duration: 2 weeks)

Objective: Ensure compliance, security measures, and data privacy.

Deliverables: Compliance measures and enhanced security features in the system.

DEFINITION:

The sprint delivery schedule provides a roadmap for developing the blockchain-based vaccine tracking system, allowing for incremental development and continuous improvements based on feedback and evolving requirements. Adjustments can be made to the schedule based on the team's velocity, complexities encountered, and changes in priorities throughout the project.

CODING

CODING & SOLUTIONING

FEATURE 1

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<p>Project Summary</p> In this critical moment, COVID-19 data is being collected, released, analyzed, interpreted, and used to inform recovery and response efforts. D4BL has worked to consolidate state level data

to explore the disproportionate impact of COVID-19 on Black people in the US. The D4BL COVID-19 Dataset captures state-level COVID-19 cases and deaths for Black people in the United States. D4BL established a team of volunteer

data scientists to develop a codebase for automating the data extraction from state websites and storing it into this dataset. Click the link below to download the dataset or explore our codebase on github: https://github.com/d4bl/COVID19_tracker_data_extraction</p>

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    <p style="text-align: center;">
        <a target="_blank" id="github"
href="https://github.com/d4bl/COVID19_tracker_data_extraction">COVID19
Data Extraction Script on GitHub</a>
    </p>
    <p style="text-align: center;">
        <a id="github" target="_blank"
href="https://www.dropbox.com/s/m80krgfdlt912ky/latest-combined-
output_.csv?dl=0">Download Latest Combined Data Output (CSV)</a>
    </p>
    <section>
        <p><strong>How D4BL Built This Dataset, and
Why:</strong></p>
```

<p>We, at Data for Black Lives, assert that public health data must always be interpreted in the proper historical context considering the various elements of structural racism that shape the American public health ecosystem. We emphasize

the importance of considering potential impact and power surrounding whose voices are driving the interpretations of these disparities and informing proposed solutions. This is a critical moment where people

are largely considering the question: why are Black people particularly vulnerable and over-represented among COVID-19 cases and deaths? The conditions that make Black communities vulnerable to the virus are the same conditions that make Black communities vulnerable to the daily harms of structural racism.

</p>

<p>In April 2020, we convened a Movement Pulsecheck to explore this in-depth. Additionally, we began tracking which states were releasing COVID-19 data on cases and deaths disaggregated by race. We released a public demand for all

states to report this data in support of monitoring the ways structural racism exacerbates the pandemic. By the end of April 2020, we began establishing the COVID-19 Data Tracker that captures the number of Black folks reported

as having tested positive for or died from COVID-19. </p>

<p>The first iteration of this dataset involved manually clicking on each state website, taking down the number of cases and deaths for Black people, and populating that data into a <u> google sheet</u>.

Over time, as more states began reporting and we contemplated how data might change day to day, we set out on a mission to build a code base that scrapes COVID-19 race/ethnicity data from official state websites in an automated

fashion and combines these daily snapshots into a publicly available dataset.</p>

<p>The Director of Research, Jamelle Watson-Daniels, began writing code for the start of the codebase. Once it became clear that the scope of the project would be quite involved, Jamelle brought on two lead D4BL volunteers: Sydeaka

Watson and Natarajan Krishnaswami. The team encountered several challenges in their efforts to extract data from state websites.</p>

<u>Variation in data extraction methods</u>: There is no consistent reporting strategy or mechanism across state websites. State websites report COVID data in various ways including: CSV and excel worksheets, text embedded

in HTML code, text in static PDF documents, image snapshots of tables (stored as image files), Tableau dashboards and graphs (bar charts, pie charts, etc).

<u>Website changes and/or updates</u>: Often, after the team developed code to successfully extract data from a given state website, states would change their reporting mechanism. This led to the adoption of a code management

strategy in which the team would monitor the state websites and edit and at times completely rewrite the code for that state.

<u>Specialized extraction techniques</u>: The state websites that report data via image snapshots of tables and/or graphs seemed to require the use of special software such as Optical Character Recognition (OCR) in order to

enable the computer to ‘read’ the data. This non-standard technique required specialized skills.

<u>Discrepancies in reporting standards:</u> There are moments when states changed the way they count cases and deaths attributed to COVID-19 or the way these counts are reported. Thus, any dataset based on state website data

faces the challenge of how to address or account for these sudden shifts.

<u>Discrepancies in dealing with racial categories</u>: When demographic breakdowns are given, the team had to understand how cases with unknown race are accounted for in demographic percentages and whether race or race/ethnicity

categories are used for the breakdowns, e.g., “Black Non-Hispanic” or “Black or African American.”

<p>change to "these challenges, during the first week of June 2020, D4BL established a team of 6 volunteer data scientists to take on the task of developing the codebase for automating the data extraction procedure from state websites.

On April 8, when D4BL compiled and released a list of all states reporting COVID-19 infections and deaths by race, there were only 12 states publicly reporting this data. D4BL included contact information for the appropriate state offices and urged the public to demand the public release of this data by all states. To date, all states are reporting disaggregated COVID-19 data.</p>

</section>

<section>

<p>Dataset usage and best practices:</p>

<p>AVOID WEAPONIZING COVID-19 DATA -</p>

<p>COVID-19 data should not be used to determine risk. It should not be used to surveil, criminalize, cage, and/or deny critical benefits.</p>

<p>COVID-19 data should not be used to inform any of the following automated decision making systems, for example:</p>

Predictive policing and enforcement of social distancing orders (i.e., COVID-19 hot spots should not be assigned greater police presence and prioritized enforcement of social distancing measures)

Public safety assessments to determine whether a person can be released from jail or prison

Forced testing (general and antibodies testing) that would disproportionately target Black, Latinx, and/or poor communities

Denying a person credit

Reinforcing historical practices of redlining in the form of denying loans, lowering property values, and reducing public and private investments

Denying a person a job

Denying a person housing

Denying a person access to health care, treatment, or services (i.e., ventilators)

Denying a person access to public services and benefits (i.e., public transportation)

<p>INTENDED PURPOSE OF DATA - </p>

<p>COVID-19 Data should inform the implementation of the following immediate actions:</p>

Release of individuals in jails, prisons, and ICE detention facilities

Transparent, accountable, and community-informed protocols on automated decision systems used for contact tracing and other public health concerns

Consistent testing protocols and workflows in Black communities

Available and accessible testing sites and tests that meet the health needs of Black communities in light of the social determinants that cause racial health disparities,

Moratoriums on negative credit reporting, late payment fees, rental evictions, foreclosures, debt collection, and wage garnishments

Suspension of rent payments in federally-subsidized housing programs and in low-income neighborhoods for one year

Suspension of consumer and business credit payments (including mortgages, car, student, personal loans, and credit cards)

<p><u>COVID-19 Data should be used to establish a reparative stimulus plan and efforts for long-term structural change</u>.</p>

COVID-19 data should be used to issue reparations tracing back to slavery. COVID-19 data offers more evidence that reparations are needed for harms tracing back to slavery. Evidence supporting the cumulative impact of structural

racism on Black communities includes: Racial disparities in COVID-19 deaths, limited access to tests and health care, unemployment rates, and unequal loss of income. Reparations are the most viable option to rectify the

deeply entrenched inequities that have only exacerbated the impact of the pandemic for Black communities.

COVID-19 stimulus plans, government loans, and other forms of government aid must account for COVID-19 racial disparities in deaths and loss of employment. Stimulus plans must account for the unique health challenges many Black

folks face due to historical structural racism in the American public health system. Black communities need a tailored fix to recover from this pandemic in distinct ways. Otherwise, the pandemic will cause irreparable harm to Black communities that will make the promise of equity and equality a more distant reality. Additional COVID-19 stimulus plans should account for this in the allocation of dollars and relief aid.

COVID-19 data should be committed to a public data trust that would entrust the public with full agency over their data, as opposed to private or government actors. Designating the public as owners of this data would provide

the highest level of transparency and accountability--not to mention give individuals greater negotiating power to use the data to achieve better outcomes.

Data on the economic impact of COVID-19 should inform alternatives to current discriminatory financial systems (e.g. credit scores). We anticipate that this data will reveal traditionally hidden biased decision-making that

continues to disproportionately inhibit Black Communities' access to wealth in American society.

State and local health officials must reject unethical clinical studies that perform antibody and vaccine testing exclusively on poor Black communities. State and local health officials must co-develop general testing protocols

with impacted communities to protect Black communities. This would include open and public announcements about where and when COVID-19 clinical trials will take place, ensuring Black scientists and researchers contribute

to experimental planning, and providing accessible science communication surrounding experimental results.

</section>

<section>

<p>About the Team:</p>

<p>Here is a list of contributors to the development of this dataset: Jamelle Watson-Daniels (D4BL Project Lead), Sydeaka Watson (Volunteer Project Manager and Co-Technical Lead), Natarajan Krishnaswami (Volunteer Co-Technical Lead),

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<p>

<table class="table table-bordered table-hover table-condensed">

<thead>

<tr>

<th title="Field #1">Feature Name</th>

<th title="Field #2">Description</th>

</tr>

</thead>

<tbody>

<tr>

<td>Location</td>

<td>The geographic entity for which this row provides data. These can be states, counties, or cities.</td>

</tr>

<tr>

<td>Date published</td>

<td>The date as of which the underlying data was published by the reporting entity.</td>

</tr>

<tr>

<td>Date/time of data pull</td>

<td>The date/time the D4BL team ran the code to retrieve the data was retrie.</td>

</tr>

<tr>

<td>Total Cases</td>

<td>The number of confirmed COVID-19 cases reported for the location.</td>

</tr>

<tr>

<td>Total Deaths</td>

<td>The number of deaths attributed to COVID-19 reported for the location.</td>

</tr>

<tr>

<td>Count Cases Black/AA</td>

<td>The number of confirmed COVID-19 cases corresponding to “Black or African American” or “Non-Hispanic Black” reported for the location.</td>

</tr>

<tr>

<td>Count Deaths Black/AA</td>

<td>The number of confirmed COVID-19 deaths corresponding to “Black or African American” or “Non-Hispanic Black” reported for the location.</td>

</tr>

<tr>

<td>Percentage of Cases Black/AA</td>

<td>The percentage of COVID-19 cases (of those with race reported) corresponding to “Black or African American” or “Non-Hispanic Black”.</td>

</tr>

<tr>

<td>Percentage of Deaths Black/AA</td>

<td>The percentage of COVID-19 deaths (of those with race reported) corresponding to “Black or African American” or “Non-Hispanic Black”</td>

</tr>

<tr>

<td>Percentage includes unknown race?</td>

<td>Logical (True/False) indicator of whether the `Percentage of Cases Black/AA` field includes COVID-19 cases with race/ethnicity unknown</td>

</tr>

<tr>

<td>Percentage includes Hispanic Black?</td>

<td>Logical (True/False) indicator of whether the `Percentage of Deaths Black/AA` field includes COVID-19 deaths with race/ethnicity unknown</td>

</tr>

<tr>

<td>Count Cases Known Race</td>

<td>The number of cases in which race was reported and, hence, “known”</td>

</tr>

<tr>

<td>Count Deaths Known Race</td>

<td>The number of deaths in which race was reported and, hence, “known”</td>

</tr>

<tr>

<td>Percentage of Black/AA population (Census data)</td>

<td>The percentage of “Black or African American alone” individuals for the region, computed using 2013-2018 American Community Survey fields B02001_003E and B02001_001E.</td>

</tr>

</tbody>

</table>

<p>

Description of how we handled missing data: A number of state websites were not reporting data by race. For these, we extract the available data and leave the missing fields blank.

</p>

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</p>

</section>

```
        </article>



      </main>
    </div>

    <div class="clearfix"></div>
    <!-- Footer -->
    <footer class="row" id="footer">
      <ul class="icons hidden">
        <li>
          <a href="https://twitter.com/data4blacklives" target="_blank"
class="icon fa-twitter"><span class="label">Twitter</span></a
      >
     </li>
     <li>
      <a
       href="mailto:data4blacklives@gmail.com"
       class="icon fa-envelope-o"
       ><span class="label" target="_top">Email</span></a
      >
```

```
      </li>
     </ul>
     <ul class="copyright">
      <li>&copy; Data for Black Lives.</li>
      <li>Credits: <a href="https//d4bl.org">Data for Black Lives</a></li>
       </ul>
     </footer>
   </main>

   <div class="modal fade" id="squarespaceModal" tabindex="-1" role="dialog"
aria-labelledby="modalLabel" aria-hidden="true">
     <div class="modal-dialog">
       <div class="modal-content">
         <div class="modal-header">
           <button type="button" class="close" data-dismiss="modal">
      <span aria-hidden="true">×</span
      ><span class="sr-only">Close</span>
       </button>
           <h3 class="modal-title" id="lineModalLabel">EMAIL D4BL</h3>
         </div>
         <div class="modal-body email">
           <!-- content goes here -->
```

```
          <form method="POST"
action="https//formspree.io/data4blacklives@gmail.com">

            <label>Email Adress</label>

            <input type="email" name="email" placeholder="Your email" />

            <label>Message</label>

            <textarea name="message" placeholder="Your
message"></textarea>

            <br />

            <button class="btn btn-block btn-submit" type="submit">

        Send

       </button>

          </form>

        </div>

        <div class="modal-footer hidden">

          <div class="btn-group btn-group-justified" role="group" aria-
label="group button">

            <div class="btn-group" role="group">

              <button type="button" class="btn btn-default" data-
dismiss="modal" role="button">

         Close

        </button>

            </div>

            <div class="btn-group btn-delete hidden" role="group">
```

```
                    <button type="button" id="delImage" class="btn btn-default btn-
hover-red" data-dismiss="modal" role="button">

            Delete

          </button>

                </div>



                <div class="btn-group" role="group">

                    <button type="button" id="saveImage" class="btn btn-default
btn-hover-green" data-action="save" role="button">

            Save

          </button>

                </div>

              </div>

          </div>

        </div>

      </div>

    </div>


    <script
src="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/js/bootstrap.min.js"
integrity="sha384-
Tc5IQib027qvyjSMfHjOMaLkfuWVxZxUPnCJA7l2mCWNIpG9mGCD8wGNIc
PD7Txa" crossorigin="anonymous"></script>
```

```
    <script
src="//cdnjs.cloudflare.com/ajax/libs/ScrollMagic/2.0.5/ScrollMagic.min.js"></scr
ipt>

    <script
src="//cdnjs.cloudflare.com/ajax/libs/ScrollMagic/2.0.5/plugins/debug.addIndicato
rs.min.js"></script>


    <script src="main.js"></script>

</body>


</html>
```

FEATURE 2

```
<script>
    var cv = new Vue({
        el: "#app",

        data: {
            entries: [],
            modalText: "",
            showModal: false,
            sheetUrl:
"https://spreadsheets.google.com/feeds/list/11hWSj2hmUsJRWJOrBO3ybfzQtt8-r_WmAeV2gULNaGo/1/public/values?alt=json",
        },

        created() {
            this.fetchData();
        },

        methods: {
            getPdfLink(value) {
                let id = this.getID(value);
```

```
    console.log(id);
    return `https//docs.google.com/document/d/${id}/export?format=pdf`;
  },
  getID(value) {
    let val1, val2;
    if (value.includes("sharing")) {
      val1 = value.lastIndexOf("/d/") + 3;
      val2 = value.indexOf("/edit");
    } else {
      val1 = value.lastIndexOf("/d/") + 3;
      val2 = value.indexOf("/edit");
    }

    return value.slice(val1, val2);
  },
  setAndFetchReport(value) {
    this.showModal = true;
    //console.log("value", value);
    let code = this.getID(value);
    console.log(code);

    let url =
`https://docs.google.com/document/d/${code}/pub?embedded=true`;
```

```
            return axios.get(url).then((value) => {
                console.log(value);

                let f = R.replace(/<style((.|\n|\r)*?)<\/style>/, "", value.data);

                this.modalText = value.data;
                console.log($("text"));
            });
        },
        fetchData: function() {

        },
    },
});
</script>
```

PERFORMANCE TESTING

Performance testing is crucial in ensuring that the blockchain-based vaccine tracking system operates efficiently and reliably under varying conditions.

1. Define Performance Metrics:

Identify key performance indicators (KPIs) such as response time, throughput, resource utilization, and system stability under varying loads.

Determine acceptable benchmarks for each metric based on system requirements and user expectations.

2. Types of Performance Testing:

- Load Testing: Assess the system's performance under expected loads to ensure it can handle typical operations.
- Stress Testing: Evaluate system behavior under extreme conditions to determine its breaking point.
- Endurance Testing: Check system stability over a prolonged period to identify any potential degradation over time.
- Volume Testing: Test the system's capability to manage a significant volume of data without performance degradation.

RESULT

The result for a blockchain -based vaccine tracking system would ideally encompass various positive outcomes and impact in the context of healthcare, sand public safety.

Improved Transparency and Traceability:

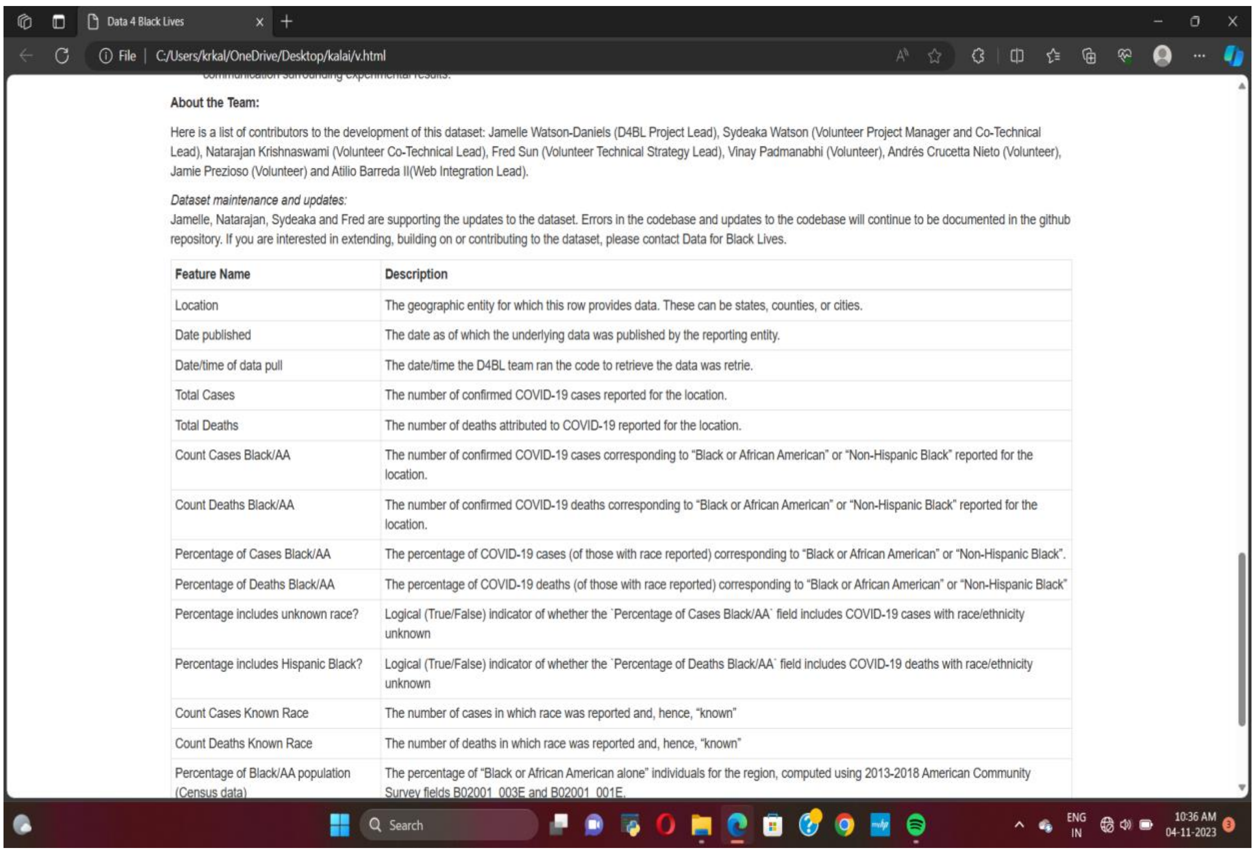
Enhanced Vaccine Tracking: The system provides a transparent and immutable record of each vaccine's journey from production to administration, ensuring traceability and authenticity:

Resource Optimization: Optimal use of resources, reduction of manual record-keeping, and minimized errors in vaccine distribution and administration.

The result is a more secure, transparent, and efficient vaccine tracking system that ensures the authenticity and proper handling of vaccines, contributing to public health, safety, and trust in the vaccination process.

OUTPUT

SCREENSHOTS



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ADVANTAGES & DISADVANTAGES

ADVANTAGES

- Transparency and Traceability: Blockchain ensures an immutable record of vaccine transactions, offering transparent and traceable information from production to administration, reducing the chances of counterfeit or fraudulent vaccines.
- Enhanced Security: Blockchain's decentralized and cryptographic nature provides a high level of security, safeguarding sensitive data and preventing unauthorized access or tampering.
- Improved Supply Chain Management:Smart contracts and real-time monitoring capabilities streamline supply chain processes, ensuring accurate tracking and verification of vaccine handling during transportation and storage.
- Data Integrity and Authenticity:The system offers authenticated, accurate, and unalterable data, ensuring the integrity and authenticity of vaccine-related information.
- Enhanced Trust and Compliance:Increased confidence in vaccine authenticity and compliance with regulations, promoting trust among consumers and healthcare providers.

DISADVANTAGES

- Technical Complexity:Implementing and maintaining a blockchain system requires specialized technical expertise, leading to higher development costs and complexity.
- Scalability Challenges:Disadvantage:Blockchain systems might face scalability issues, especially with a high volume of transactions, potentially affecting system performance.
- Regulatory and Legal Challenges:Disadvantage:Adherence to changing regulations and legal standards related to data protection and healthcare can pose challenges.
- Resource Consumption:Disadvantage:Blockchain systems can be resource-intensive, requiring significant computational power and energy consumption.
- Integration Complexity:Disadvantage:Integrating with existing systems and ensuring interoperability with different technologies can be complex and time-consuming.

CONCLUSION

In conclusion, the implementation of a blockchain-based vaccine tracking system presents a significant opportunity to revolutionize the transparency, security, and efficiency of vaccine supply chains. By leveraging blockchain technology, this system offers an immutable and transparent ledger of vaccine transactions, ensuring authenticity, traceability, and enhanced security throughout the vaccine's lifecycle, from production to administration.

The advantages of this system include unparalleled transparency and traceability, improved security through decentralization and cryptographic safeguards, as well as streamlined supply chain management with features like smart contracts and real-time monitoring. Additionally, the system enhances trust, compliance, and data integrity, fostering confidence among stakeholders in the authenticity and handling of vaccines.

However, while the benefits are substantial, challenges exist. Technical complexity, scalability concerns, regulatory and legal compliance, resource consumption, and integration difficulties may pose obstacles to the seamless implementation and operation of a blockchain-based vaccine tracking system.

Despite these challenges, the advantages outweigh the disadvantages, presenting a powerful solution to address the pressing need for secure and transparent vaccine supply chain management. The system's potential to strengthen public health, ensure vaccine authenticity, and provide a trustworthy and traceable record of vaccine movements signifies a substantial step forward in safeguarding global health initiatives.

Moving forward, careful consideration of technical intricacies, strategic planning, adaptability to regulatory changes, and seamless integration with existing systems will be vital to overcome challenges and fully realize the potential benefits of a blockchain-based vaccine tracking system. With meticulous planning and execution, this innovative solution has the capability to significantly enhance public health and safety, laying the groundwork for a more secure and transparent future in vaccine distribution and administration.

FUTURE SCOPE

The future scope of a blockchain-based vaccine tracking system presents a transformative landscape with potential advancements in healthcare and supply chain management. This includes enhanced interoperability with emerging technologies, expanded use cases beyond vaccines, global collaboration, continuous technological advancements, and improvements in regulatory compliance. The potential for patient-controlled health records, decentralized healthcare ecosystems, and sustainable supply chain optimization through smart contracts and predictive analytics further signify a promising future for secure, transparent, and efficient healthcare ecosystems. Continued innovation and adaptation will drive the evolution and widespread adoption of blockchain technology in healthcare, ensuring its pivotal role in shaping a secure and reliable future for healthcare administration.