BLOCKCHAIN TECHNOLOGY FOR ELECTRONIC HEALTH RECORDS

NAAN MUDHALVAN

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PROJECT REPORT

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NAGERCOIL- 3

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CHAPTER 1

INTRODUCTION

1.1 PROJECT OVERVIEW

Electronic Health Records (EHRs), also known as Electronic Medical Records (EMRs), are digital versions of patients' paper medical charts. They contain a patient's medical history, treatment plans, test results, and other essential healthcare information. Here is an overview of electronic health records. EHRs are designed to improve the quality and efficiency of patient care. They provide a comprehensive view of a patient's health information and can be accessed and shared by authorized healthcare professionals. EHRs aim to streamline healthcare processes, reduce errors, and enhance patient outcomes.

Key Components:

Patient Demographics: Basic information about the patient, including name, address, date of birth, and contact details.

Medical History: Details of past illnesses, surgeries, and medical conditions.

Medication and Allergies: A list of current medications, dosages, and any known allergies.

Diagnostic Test Results: Laboratory and imaging test results, such as blood tests, X-rays, and MRIs.

Treatment Plans: Information on prescribed treatments, medications, and care plans.

Progress Notes: Records of healthcare providers' observations and interactions with the patient.

Immunization Records: Information about vaccines and immunization history.

Billing and Insurance Information: Data related to billing, insurance claims, and payments.

Benefits:

Improved Access: EHRs can be accessed remotely, enabling healthcare professionals to view patient records from different locations.

Data Accuracy: Reduced risk of errors due to illegible handwriting or lost paper records.

Efficiency: Streamlined workflows and reduced administrative tasks.

Interoperability: EHRs can be shared among different healthcare providers and institutions.

Decision Support: EHRs may include clinical decision support tools to aid healthcare providers in making informed decisions.

Patient Engagement: Some EHR systems provide patient portals for patients to access their own records, schedule appointments, and communicate with their healthcare providers.

Challenges:

Implementation Costs: Initial setup and training can be expensive.

Data Security and Privacy: Protecting patient data from breaches and unauthorized access is crucial.

Interoperability Issues: Different EHR systems may not always seamlessly communicate with each other.

Learning Curve: Transitioning from paper records to EHRs can require time and effort.

Data Entry Burden: Data entry into EHR systems can be time-consuming for healthcare providers.

Regulations: Many countries have regulations in place to ensure the privacy and security of EHRs. For example, in the United States, the Health Insurance Portability and Accountability Act (HIPAA) establish standards for the protection of patient information. Future Trends: EHRs are evolving with the integration of technologies like artificial intelligence (AI), telemedicine, and block chain to improve data analysis, remote monitoring, and data security. EHRs have become a fundamental tool in modern healthcare, facilitating better patient care, research, and administrative processes. However, their effective use and secure management remain important considerations in the healthcare industry.

1.2 PURPOSE

EHRs are designed to improve the quality and efficiency of patient care. They provide a comprehensive view of a patient's health information and can be accessed and shared by authorized healthcare professionals. EHRs aim to streamline healthcare processes, reduce errors, and enhance patient outcomes.

CHAPTER 2

LITERATURE SURVEY

2.1 EXISTING PROBLEM

Electronic Health Records (EHRs) have brought significant improvements to healthcare, but they are not without their challenges and problems. Some of the existing issues in EHR systems include:

Interoperability: One of the most prominent problems in EHRs is the lack of interoperability. EHR systems from different vendors often have difficulty exchanging data seamlessly. This can lead to incomplete patient records and hinder the sharing of vital medical information between healthcare providers, institutions, and systems.

User Interface and Usability: Many EHR systems have complex, non-intuitive interfaces, which can be frustrating for healthcare professionals. Poor usability can lead to data entry errors, workflow inefficiencies, and provider dissatisfaction.

Data Entry Burden: Healthcare providers often spend a significant amount of time inputting data into EHRs. This administrative burden can lead to reduced face-to-face time with patients and contribute to burnout among clinicians.

Alert Fatigue: EHRs are equipped with clinical decision support systems that generate alerts and notifications for various issues, such as medication interactions. However, these alerts can become overwhelming and lead to "alert fatigue," where healthcare providers may ignore or overlook critical alerts.

Data Security and Privacy: With the digitization of health records, data security and privacy have become significant concerns. Breaches can expose sensitive patient information, leading to identity theft and other privacy violations.

Data Accuracy: Errors in data entry, typos, or misinterpretation can occur and compromise the accuracy of EHRs. Inaccurate data can affect patient care decisions and lead to potential medical errors.

Training and Education: Healthcare providers and staff may not receive adequate training to use EHR systems effectively. This knowledge gap can hinder the adoption and utilization of EHRs to their full potential.

Data Overload: EHRs can contain vast amounts of information, making it challenging to find relevant data quickly. This information overload can be overwhelming for healthcare providers, impacting decision-making.

Cost and Implementation Challenges: The initial costs of implementing EHR systems, including software, hardware, training, and data migration, can be substantial. Smaller healthcare facilities may struggle with these costs, and implementation can disrupt existing workflows.

Regulatory Burden: Compliance with government regulations and standards, such as HIPAA in the United States, can be challenging and add an administrative burden to healthcare organizations.

Patient Access and Engagement: While EHRs are meant to empower patients to access and manage their health records, the actual implementation of patient portals and patient engagement features can vary widely, and not all patients may have the skills or technology access to utilize these tools effectively.

Vendor Lock-In: Switching EHR vendors can be complicated and costly, leading to a degree of vendor lock-in. This can limit a healthcare organization's ability to adapt to changing needs and technologies.

Efforts are ongoing to address these challenges in EHR systems, with a focus on improving interoperability, usability, data security, and reducing the administrative burden on healthcare providers. Additionally, advancements in technology, such as the use of artificial intelligence and block chain, are being explored to enhance EHR capabilities and address some of these issues.

2.2 REFERENCES

Certainly, here are some references and sources that you can explore for more information on electronic health records (EHRs):

Books:

"Electronic Health Records: Understanding and Using Computerized Medical Records" by Richard Gartee

"Health Informatics: An Interprofessional Approach" by Ramona Nelson and Nancy Staggers

"Electronic Health Records: A Practical Guide for Professionals and Organizations" by Margret K. Amatayakul

Academic Journals and Articles:

Jha, A. K., Doolan, D., Grandt, D., Scott, T., & Bates, D. W. (2008). The Use of Health Information Technology in Seven Nations. International Journal of Medical Informatics, 77(12), 848-854.

Adler-Milstein, J., Jha, A. K. (2017). HITECH Act Drove Large Gains in Hospital Electronic Health Record Adoption. Health Affairs, 36(8), 1416-1422.

Zhou, L., Soran, C. S., Jenter, C. A., & Volk, L. A. (2010). The Relationship between Electronic Health Record Use and Quality of Care over Time. Journal of the American Medical Informatics Association, 17(4), 457-464.

Government and Regulatory Sources:

Office of the National Coordinator for Health Information Technology (ONC): The ONC, a division of the U.S. Department of Health and Human Services, provides extensive resources and publications related to EHRs and health information technology.

Healthcare Organizations and Associations:

American Health Information Management Association (AHIMA): AHIMA offers publications and resources related to health information management, including EHRs.

American Medical Association (AMA): The AMA provides information on EHR implementation and best practices for physicians.

Whitepapers and Reports:

"Electronic Health Records: The 2020 Perspective" by Cerner: This whitepaper provides insights into the current state of EHRs, including trends and challenges.

"Adoption of Electronic Health Record Systems among U.S. Non-Federal Acute Care Hospitals" by the Office of the National Coordinator for Health Information Technology (ONC): This report provides statistics and insights into EHR adoption rates among U.S. hospitals.

Websites and Online Resources:

The websites of leading EHR vendors like Epic, Cerner, and Allscripts often provide resources, case studies, and articles on EHR implementation and usage.

Remember to verify the relevance and currency of the sources you consult, as the field of electronic health records is continually evolving.

2.3 PROBLEM STATEMENT DEFINITION

A well-defined problem statement for electronic health records (EHRs) could be:

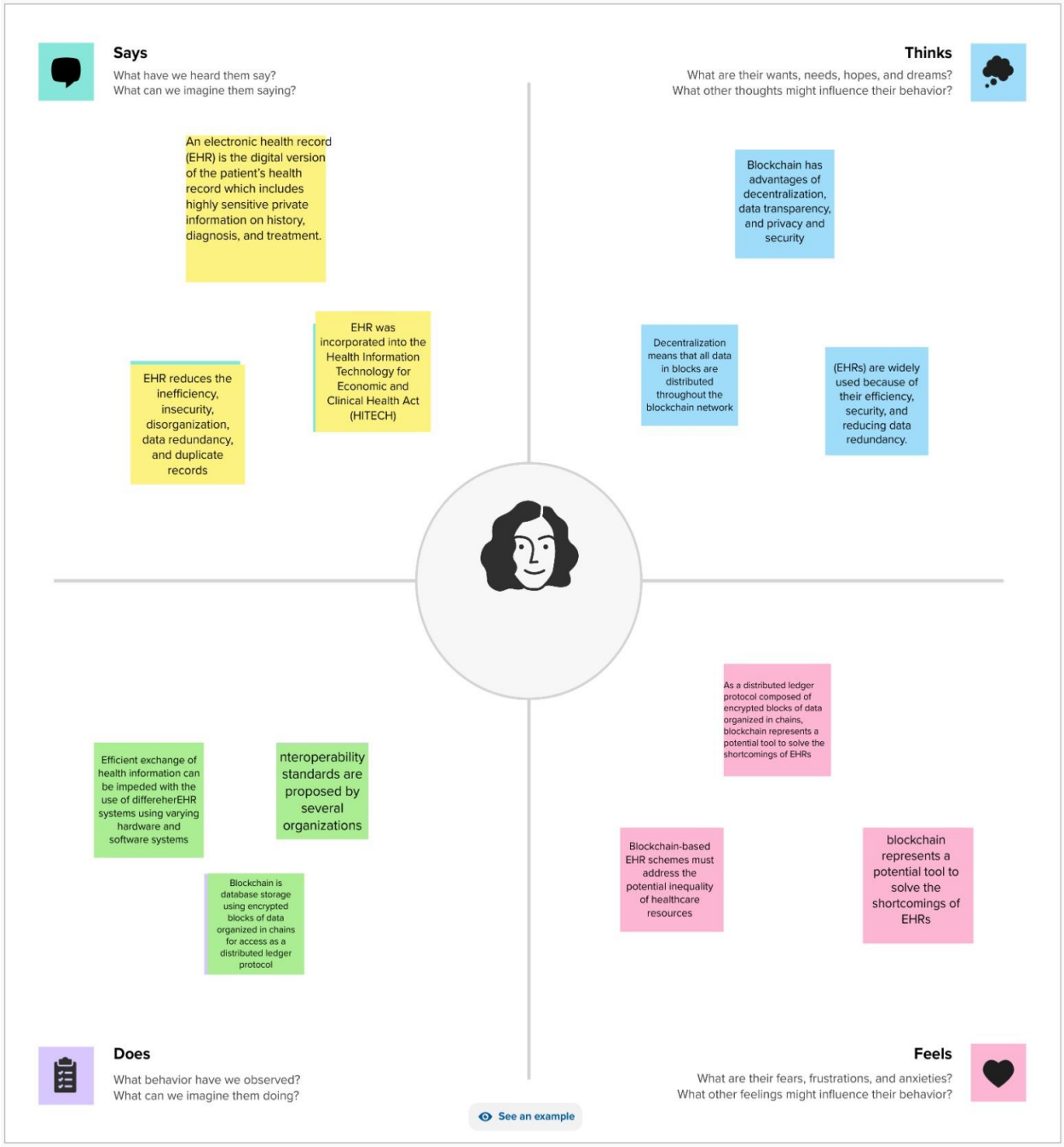
"The challenge is to create and maintain an interoperable and user-friendly electronic health record system that ensures the secure and efficient exchange of patient information among healthcare providers while addressing usability issues, data security concerns, and regulatory requirements, ultimately enhancing patient care, reducing administrative burden, and mitigating risks related to data breaches and medical errors."

This problem statement encapsulates the key issues and objectives in the context of EHRs, including interoperability, user-friendliness, data security, regulatory compliance, and the overall goal of improving healthcare outcomes. Depending on your specific goals or research, you may need to tailor the problem statement further to address a more specific aspect of EHRs.

CHAPTER 3

IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



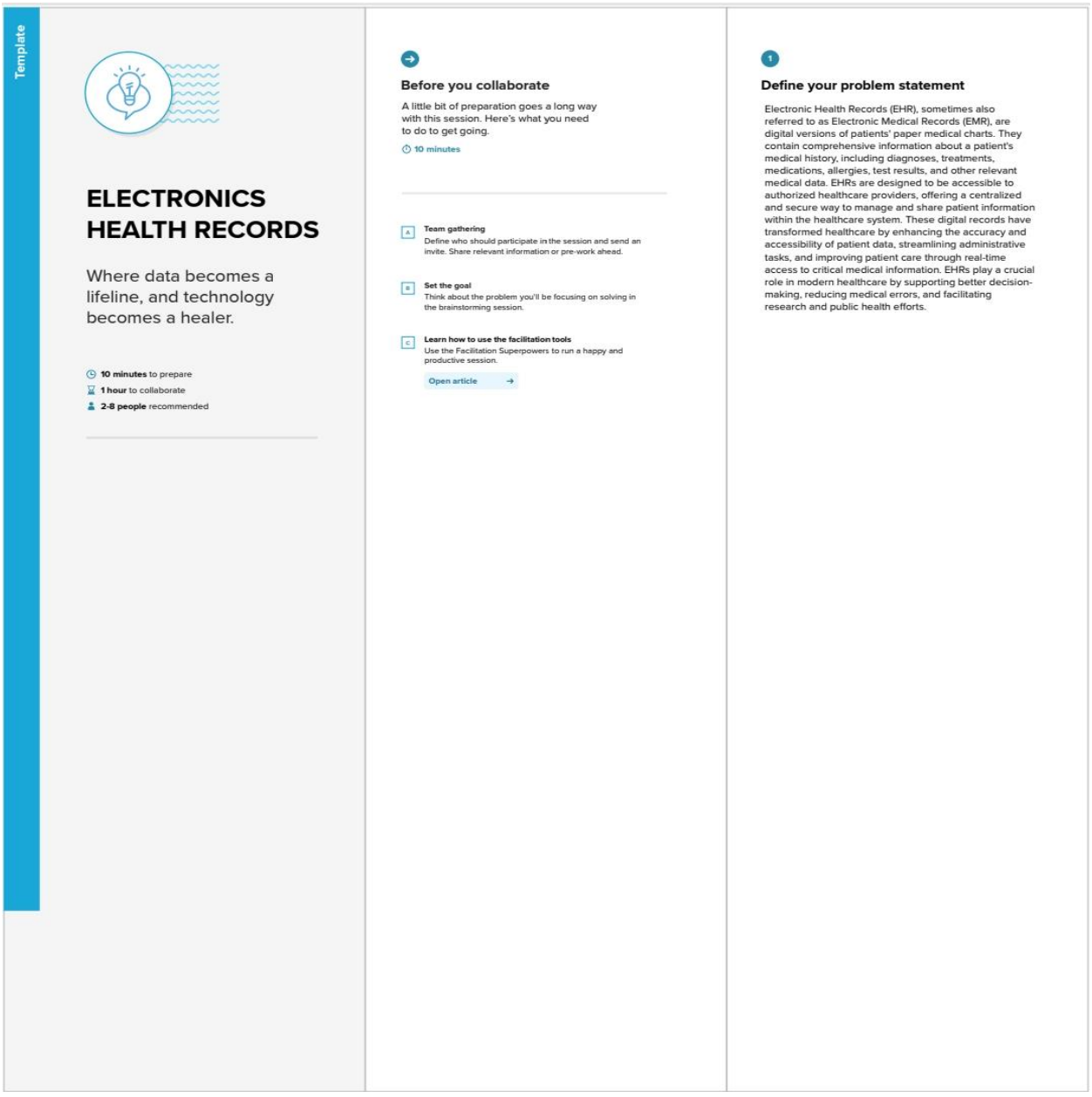
3.2 IDEATION & BRAINSTORMING

In the development of the “Block chain – Based drug traceability System," the project team engaged in a comprehensive ideation and brainstorming process to explore various potential solutions and features that can enhance the system's functionality. The following innovative ideas and strategies were considered:

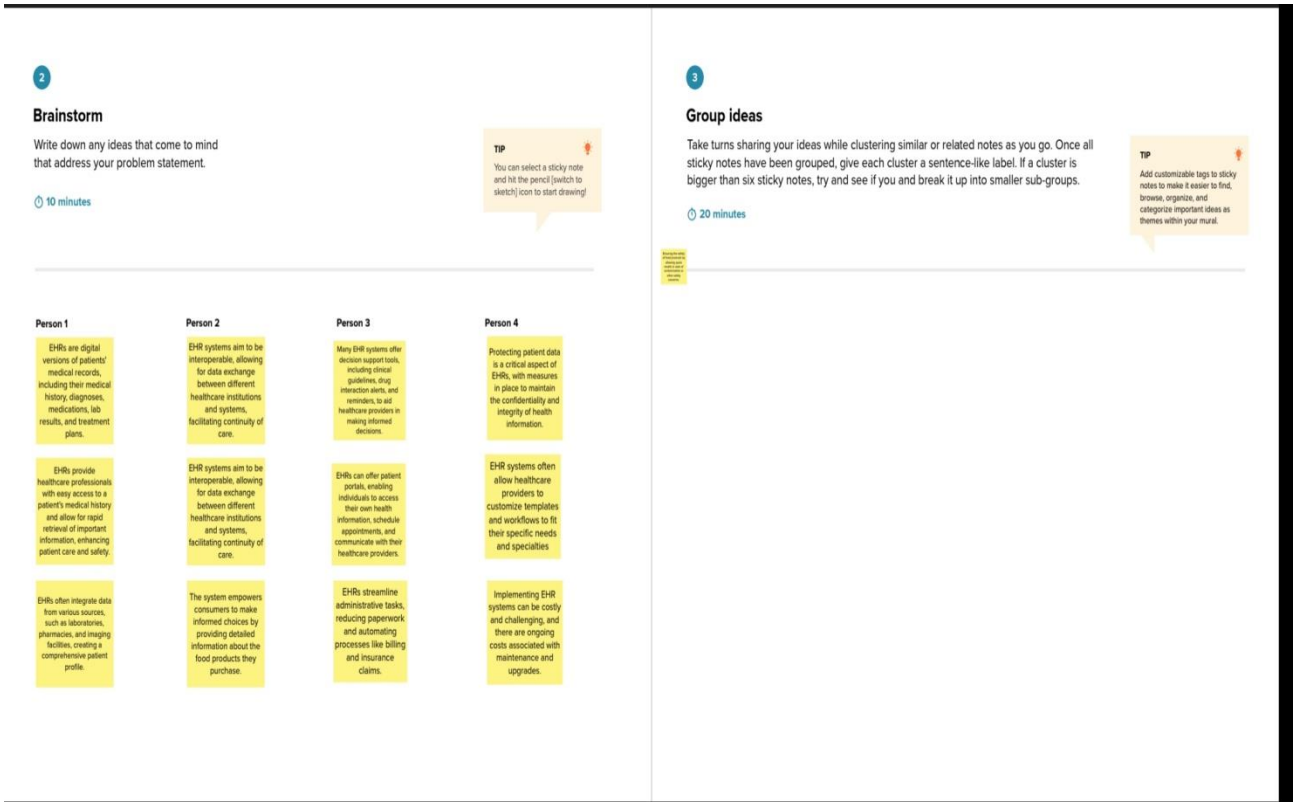
Supply chain is typically centralized and lack transparency across participants of the supply chain, which allows the central authority to modify information without notifying other stakeholders. On the other hand, a block chain based solution offers data security, transparency, immutability, provenance and authenticated transaction records. Block chain is a decentralized, immutable shared ledger that can be applied to a variety of business settings involving transaction processes. Transparency and traceability are used interchangeably however, they represent very different concepts. Transparency is usually used when referring to high-level information of a supply chain. For example, product’s components, facilities locations, names of suppliers, etc. with the objective to map the whole supply chain. However, traceability is related to granular information where it envisages choosing a specific component to trace, determines common standards to communicate with partners, implements methods to produce and gather accurate data, selects a platform to store traceability data, and determines how to share data on the platform. Although both terms represent different concepts, they rely on each other because accessing granular information requires full understanding of the supply chain. In this respect, a number of existing approaches leverage cryptographic properties of block chain to achieve a decentralized, verifiable track and trace system for pharmaceutical drugs. Mettler et al. [32] have discussed the use of blockchain based approach for various issues in healthcare sector with no technical details or specific

application. Kurki [33], presented the advantages of blockchain technology in pharmaceutical supply chain. However, similar to [32] only conceptual discussion was provided. Muniandy and Ong [20] proposed a traceability system using Ethereum for anticounterfeiting. The proposed solution employs smart contract however it lacks implementation or evaluation.

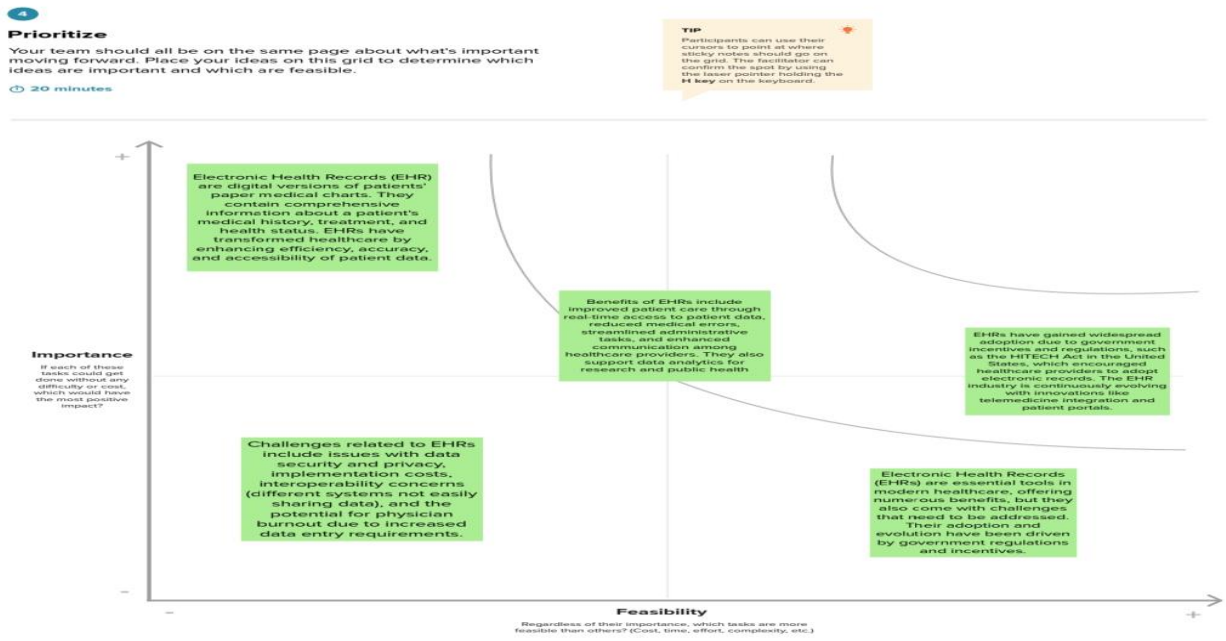
Step-1: Team Gathering, Collaboration & Select the Problem Statement



Step-2: Brainstorm, Idea Listing and Grouping



Step-3: Idea Prioritization



CHAPTER 4

REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

Decision Support:

Provide clinical decision support tools, including drug-drug interaction checks, clinical guidelines, and alerts for clinical warnings.

Assist healthcare providers in making informed decisions.

Interoperability:

Support standardized data exchange formats and protocols, enabling seamless communication with other EHR systems, healthcare providers, and public health agencies.

Security and Access Control:

Implement robust access control mechanisms to ensure that only authorized users can view and modify patient records.

Encrypt patient data to protect it from unauthorized access and breaches.

Audit Trails:

Maintain an audit trail to track all user interactions with patient records, helping to identify any unauthorized access or data modifications.

Patient Portals:

Offer secure patient portals that allow patients to access their own health records, schedule appointments, and communicate with healthcare providers.

Billing and Claims:

Support billing and claims generation, including the ability to generate electronic claims for insurance purposes.

Ensure compliance with healthcare coding and billing standards.

Reporting and Analytics:

Provide reporting and analytics tools to analyze patient data, monitor clinical outcomes, and support research and quality improvement initiatives.

Data Backup and Recovery:

Implement data backup and disaster recovery mechanisms to ensure data integrity and availability in the event of system failures or disasters.

Customization and Integration:

Allow for system customization to adapt to specific clinical workflows and needs.

Enable integration with other healthcare systems, such as practice management software.

Mobile Access:

Support mobile access to EHRs, allowing healthcare providers to access patient data from Smartphone's and tablets securely.

Regulatory Compliance:

Ensure compliance with healthcare regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States or regional data protection laws.

Patient Consent and Privacy Management:

Enable patients to control who can access their records and under what conditions, in compliance with privacy regulations.

These functional requirements are essential for a comprehensive and effective EHR system, which plays a critical role in improving patient care, enhancing operational efficiency, and safeguarding patient information in healthcare settings. The specific requirements may vary based on the needs and regulations of different healthcare organizations and regions.

4.2 NON-FUNCTIONAL REQUIREMENTS

The EHR system should comply with healthcare regulations and standards, such as HIPAA in the United States, to ensure data privacy and integrity.

Usability:

The user interface should be intuitive, user-friendly, and designed to minimize errors, ensuring that healthcare providers can effectively and efficiently use the system.

Interoperability:

EHR systems should be capable of exchanging data with other EHR systems, medical devices, and healthcare software, using standardized protocols and formats.

Data Integrity:

The system must maintain the accuracy and consistency of patient data, minimizing errors or data corruption.

Data Backup and Recovery:

Regular data backups and disaster recovery processes should be in place to safeguard data in case of system failures or disasters.

Audit ability:

The system should maintain detailed audit trails, recording all user interactions with patient records for monitoring and security purposes.

Response Time:

The system should provide prompt response times for user interactions, ensuring that healthcare providers do not experience delays when accessing or updating patient records.

Capacity:

The EHR system should have adequate storage and processing capacity to manage the expected volume of patient data.

Accessibility:

Ensure that the EHR system is accessible to users with disabilities, meeting accessibility standards like the Web Content Accessibility Guidelines (WCAG).

Integration with Legacy Systems:

The EHR system should be able to integrate with existing healthcare systems, including legacy software, to maximize its utility and value.

Training and Support:

Provide training resources and customer support to help users learn how to use the system effectively and troubleshoot issues.

Mobile Accessibility:

Ensure that the system is accessible and usable on mobile devices for healthcare providers who need to access EHRs on the go.

Data Retention:

Define data retention policies and mechanisms for archiving and purging patient data in compliance with legal and regulatory requirements.

Data Portability:

Allow for easy migration of patient data in a standardized format if the organization decides to switch EHR systems or if patients want to transfer their data.

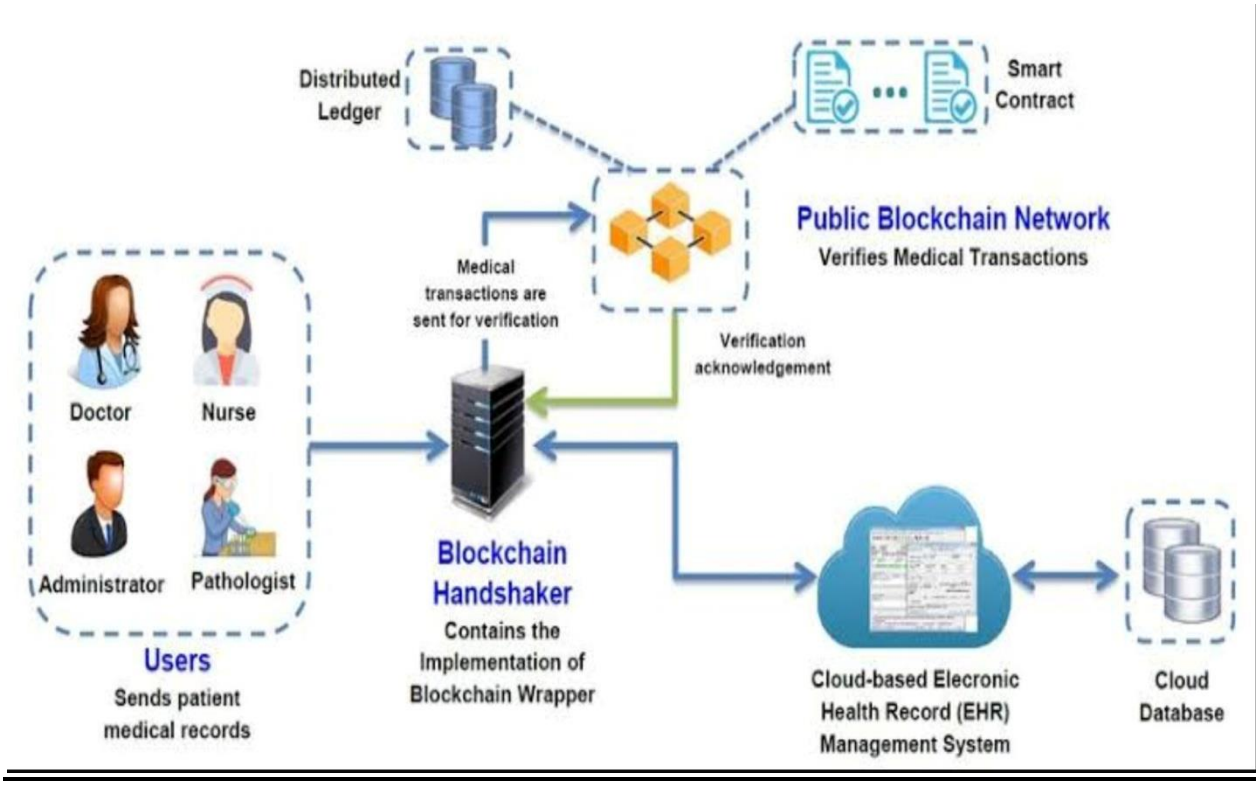
These non-functional requirements are critical for the success of an EHR system. They focus on aspects such as system reliability, security, performance, and compliance, which are essential for providing safe and efficient healthcare services while safeguarding patient information.

CHAPTER 5

PROJECT DESIGN

5.1 DATA FLOW DIAGRAMS & USER STORIES

DATA FLOW DIAGRAMS:



USER STORIES:

User stories are a helpful way to define the functionality and requirements of electronic health record (EHR) systems from the perspective of different users, including healthcare providers, administrators, and patients. Here are some user stories for EHR systems:

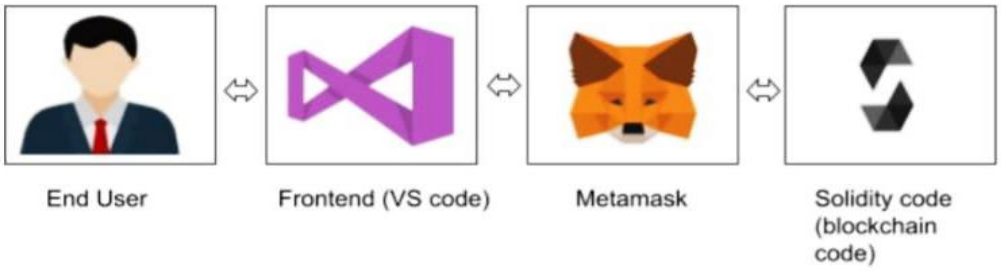
- As a physician, I want to easily access a patient's complete medical history with a single click, so I can make informed clinical decisions and provide the best possible care.
- As a nurse, I want the EHR system to send automated medication administration reminders and dosage calculations to reduce medication errors and improve patient safety.

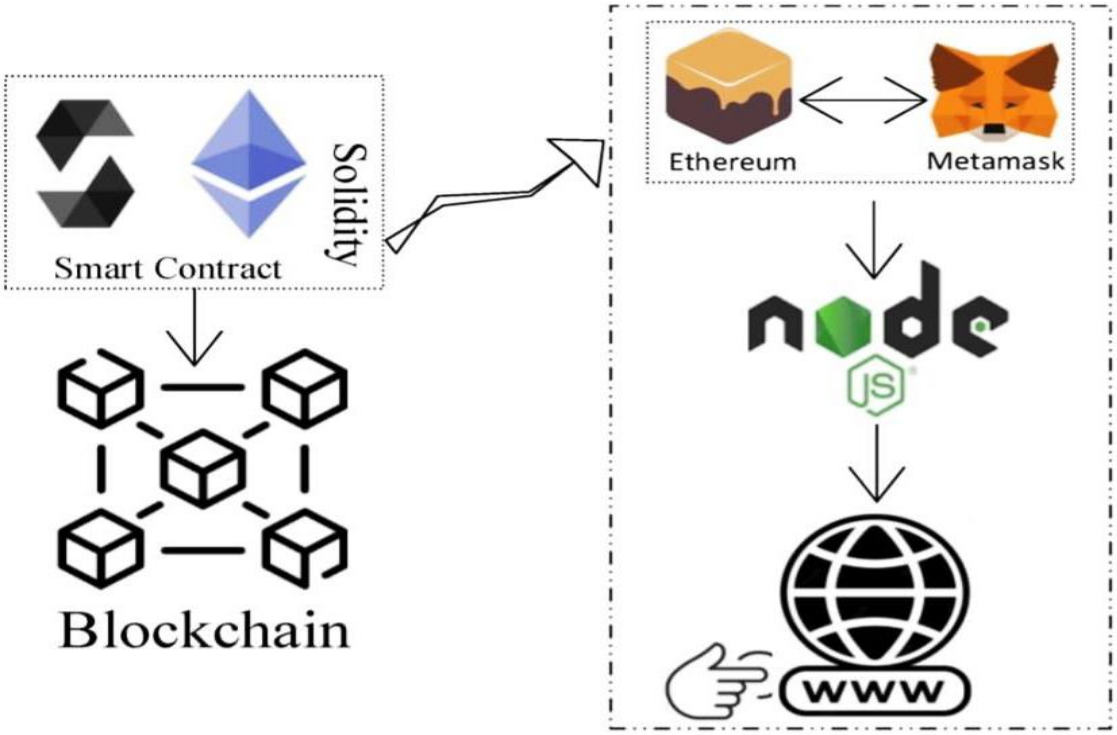
- As a front desk administrator, I want the ability to quickly check patients in and out, verify insurance information, and schedule appointments within the EHR system to streamline the check-in process and reduce patient wait times.
- As a patient, I want to access my own health records through a secure patient portal, so I can review my medical history, test results, and upcoming appointments, and communicate with my healthcare provider online.
- As a radiologist, I want the EHR system to seamlessly integrate with the PACS (Picture Archiving and Communication System) for efficient access to imaging studies, allowing me to interpret and report on diagnostic images promptly.
- As a pharmacist, I want the EHR system to provide real-time medication information, including dosage instructions and potential drug interactions, to ensure safe and accurate medication dispensing.
- As a healthcare administrator, I want robust reporting and analytics tools in the EHR system to help monitor and improve patient outcomes, optimize resource allocation, and ensure regulatory compliance.
- As a laboratory technician, I want the EHR system to automatically receive electronic test orders from physicians, process samples efficiently, and transmit test results directly to the patient's medical record.
- As a patient, I want to be able to share my health records securely with specialists or other healthcare providers outside of my primary care network to ensure coordinated and comprehensive care.
- As a compliance officer, I want the EHR system to provide comprehensive audit trails for all user interactions with patient records to ensure data integrity and security, as well as regulatory compliance.
- As a physician, I want the EHR system to provide clinical decision support, offering evidence-based treatment recommendations and alerts for potential medication allergies or contraindications.
- As a paediatrician, I want the EHR system to support growth charts and age-appropriate clinical decision support to help me manage and monitor child development.
- As an emergency room nurse, I want a triage module within the EHR system that allows for quick assessment and prioritization of patients based on the severity of their conditions.
- As a psychiatrist, I want the EHR system to offer templates and tools specifically designed for mental health assessments, diagnoses, and treatment planning.

- As a patient, I want the EHR system to enable me to grant or revoke permission for specific healthcare providers to access my records, ensuring my privacy and control over my health information.

These user stories represent a variety of roles and perspectives within the healthcare ecosystem, highlighting the diverse needs and requirements of EHR users. Each story can serve as a starting point for developing features and functionality within an EHR system.

5.2 SOLUTION ARCHITECTURE

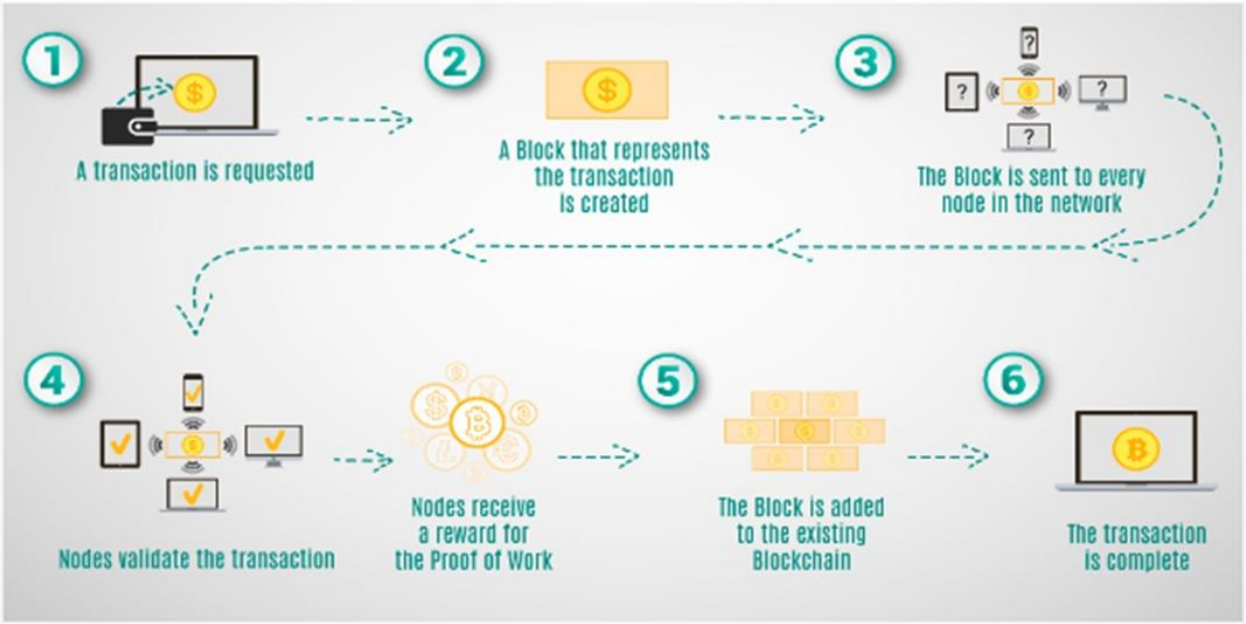




CHAPTER 6

PROJECT PLANNING & SCHEDULING

6.1 TECHNICAL ARCHITECTURE



6.2 SPRINT PLANNING & ESTIMATION

Sprint planning and estimation are crucial components of agile project management, and they can be applied to the development and enhancement of electronic health records (EHR) systems. Here's how you can approach sprint planning and estimation for EHR development:

1. Define the Product Backlog:

Begin by creating a product backlog that includes all the features, user stories, and tasks needed for EHR development. This backlog should be a prioritized list based on the most important user needs and business goals.

2. Assemble the Development Team:

The development team should include software developers, UI/UX designers, quality assurance specialists, and domain experts in healthcare. A cross-functional team is essential for addressing the multifaceted requirements of EHR development.

3. Conduct Sprint Planning:

Determine the length of your sprints (typically 2-4 weeks) and schedule sprint planning meetings. During these meetings, the team selects items from the product backlog to work on during the upcoming sprint.

Discuss the user stories and tasks, clarify any doubts, and make sure everyone understands the requirements.

4. Story Point Estimation:

Use story point estimation to estimate the effort required for each user story or task. This can be done using techniques like Planning Poker, where team members assign story points to each item.

Story points are a relative measure of complexity, not an absolute measure of time. They help in prioritizing and planning work.

5. Capacity Planning:

Calculate the team's capacity for the sprint. Consider factors like team members' availability, holidays, and any non-development tasks that might reduce their capacity.

6. Select User Stories for the Sprint:

Based on the team's capacity and the story point estimates, select user stories from the product backlog that collectively fit within the sprint.

7. Create a Sprint Goal:

Define a clear sprint goal that outlines what the team aims to accomplish during the sprint. This provides a sense of purpose and direction for the team.

8. Break User Stories into Tasks:

For each selected user story, break it down into smaller tasks that need to be completed to achieve the story. Assign these tasks to team members based on their skills and expertise.

9. Sprint Backlog:

The sprint backlog is the list of user stories and tasks selected for the sprint. It should be visible to the team, and progress should be tracked during the sprint.

10. Daily Stand-up Meetings:

Conduct daily stand-up meetings to monitor progress, discuss any obstacles, and make necessary adjustments to the plan.

11. Sprint Review:

At the end of the sprint, hold a sprint review meeting where the team demonstrates the completed work to stakeholders and collects feedback.

12. Sprint Retrospective:

After the review, conduct a sprint retrospective to reflect on the sprint's successes and areas for improvement. Use this feedback to refine the process for the next sprint.

13. Iterative Development:

Continue with subsequent sprints, incorporating user feedback and making adjustments to the product backlog as needed. This iterative approach allows for flexibility and continuous improvement.

14. Documentation and Compliance:

Ensure that the development process complies with relevant healthcare regulations, such as HIPAA, and maintain documentation for auditing purposes.

Sprint planning and estimation in EHR development help manage project scope, improve transparency, and ensure that the most valuable features are delivered in a systematic and controlled manner. Additionally, it allows teams to adapt to changing requirements and prioritize patient safety and data security throughout the development process.

6.3 SPRINT DELIVERY SCHEDULE

Creating a sprint delivery schedule for the development of electronic health records (EHR) involves organizing and planning the work over a series of sprints to ensure that features and improvements are delivered in a structured and predictable manner. Here's how you can create a sprint delivery schedule for EHR development:

1. Define the Overall Project Timeline:

Start by establishing the overarching project timeline, which includes the expected start and end dates for the entire EHR development project. This will help provide context for sprint planning.

2. Set Sprint Durations:

Determine the duration of each sprint. Sprints typically last 2-4 weeks, depending on the complexity of the tasks and the team's preferences.

3. Identify High-Priority Features and Milestones:

Identify the high-priority features, functionalities, or milestones that are essential for the EHR system's initial release or for addressing critical needs in healthcare delivery. These features should be included in early sprints.

4. Create a Sprint Schedule:

Based on the sprint duration, the project timeline, and the high-priority features, create a sprint schedule. Start with the first sprint, specifying its start and end dates.

5. Allocate User Stories and Tasks:

Assign user stories and tasks to each sprint based on their priority and complexity. Ensure that the stories selected for each sprint align with the sprint goal and deliver value to users.

6. Iterative Development:

Plan for iterative development, where each sprint builds upon the previous ones. Features and functionalities are enhanced and refined with each sprint, leading to an incrementally improved EHR system.

7. Accommodate Testing and Quality Assurance:

Allocate time within each sprint for testing and quality assurance to ensure that the delivered features are functional and meet the required quality standards.

8. Sprint Reviews and Retrospectives:

Schedule sprint review meetings at the end of each sprint to showcase the completed work and gather feedback. Follow these with sprint retrospectives to reflect on the process and make improvements.

9. Plan for Regulatory Compliance:

If the EHR system must comply with healthcare regulations (e.g., HIPAA), ensure that compliance activities and documentation are integrated into the sprint schedule.

10. Flexibility and Adjustments:

Maintain flexibility in the schedule to accommodate changes in priorities, unexpected issues, and feedback from stakeholders. Be prepared to adjust the sprint schedule as needed.

11. Communication and Transparency:

Communicate the sprint schedule to the development team, stakeholders, and end-users to ensure transparency and alignment with project goals.

12. User Acceptance Testing (UAT):

Allocate time for user acceptance testing at the end of the development process to allow end-users to verify that the EHR system meets their needs and expectations.

13. Documentation and Training:

Incorporate time for documenting features, functionalities, and any necessary user training as part of the sprint schedule.

14. Final Release:

Plan for the final release of the EHR system, which may encompass a comprehensive set of features and capabilities after multiple sprints.

15. Ongoing Support and Maintenance:

After the initial release, allocate time for ongoing support, maintenance, and future feature enhancements.

16. Communication and Reporting:

Maintain regular communication with stakeholders and provide progress reports to keep them informed about the sprint delivery schedule and the project's status.

Creating a sprint delivery schedule for EHR development is an ongoing and dynamic process that requires regular reviews and adjustments. It ensures that features are delivered incrementally and align with the evolving needs of healthcare providers, organizations, and patients.

CHAPTER 7

CODING & SOLUTIONING

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;

contract HealthRecords {

    struct PatientRecord {
        string Name;
        address patientAddress;
        string dieses;
        string contactInfo;
    }

    mapping(uint256 => PatientRecord) public records;

    event RecordCreated(uint256 indexed recordId, address indexed
patientAddress);
    event RecordTransferred(
        uint256 indexed recordId,
        address indexed from,
        address indexed to
    );



    modifier onlyOwner(uint256 recordId) {
        require(msg.sender == records[recordId].patientAddress,"Only contract
owner can call this");
        _;
    }

    function createRecord(
        uint256 recordId,
        string memory name, address _patientAddress, string memory _diseases,
string memory _contactInfo
    ) external {
```

```
        records[recordId].Name = name;
        records[recordId].patientAddress = _patientAddress;
        records[recordId].dieses = _diseases;
        records[recordId].contactInfo = _contactInfo;

        emit RecordCreated(recordId, _patientAddress);
    }

    function transferRecord(uint256 recordId, address newOwner) external
onlyOwner(recordId) {

        //require(records[recordId].patientAddress == newOwner, "New Owner
should have different Address");

        require(records[recordId].patientAddress == msg.sender, "Only record owner
can transfer");

        records[recordId].patientAddress = newOwner;

        emit RecordTransferred(recordId, records[recordId].patientAddress,
newOwner);
    }

    function getRecordData(
        uint256 recordId
    ) external view returns (string memory, address, string memory,string memory)
{
        return (records[recordId].Name,
        records[recordId].patientAddress,
        records[recordId].dieses,
        records[recordId].contactInfo);
    }

    function getRecordOwner(uint256 recordId) external view returns (address) {
        return records[recordId].patientAddress;
    }
}
```

7.1 FEATURE 1

Product Registration and Update:

The smart contract allows for the registration and updating of products. Users can add information about a drug product, including its name, description, and quantity. This feature is essential for tracking and recording data about various drug products within the block chain. Users, such as suppliers, can update the product information as needed, ensuring that the data remains accurate and up to date.

7.2 FEATURE 2

Ownership Control:

The contract includes an ownership control mechanism. Only the owner of a particular product (as specified by the ‘owner’ field) can perform actions such as updating the product's information. This feature enhances data security and ensures that only authorized users can modify the information associated with specific products.

7.3 DATABASE SCHEMA

Designing a database schema for electronic health records (EHR) is a complex task that requires careful consideration of various factors, including data structure, relationships, data security, and compliance with healthcare regulations (e.g., HIPAA in the United States). Below is a simplified database schema for EHR that serves as a starting point. In a real-world scenario, the schema would be much more extensive and may vary based on specific organizational needs. The example below uses a relational database model.

Entities and Their Relationships:

Patient:

Attributes: Patient ID (Primary Key), First Name, Last Name, Date of Birth, Gender, Contact Information, Emergency Contact, Insurance Details, etc.

Healthcare Provider:

Attributes: Provider ID (Primary Key), First Name, Last Name, Specialization, Contact Information, etc.

Visit:

Attributes: Visit ID (Primary Key), Patient ID (Foreign Key), Provider ID (Foreign Key), Visit Date, Visit Reason, Diagnosis, Treatment, Prescription, etc.

Medication:

Attributes: Medication ID (Primary Key), Medication Name, Dosage, Instructions, Patient ID (Foreign Key), Provider ID (Foreign Key), Prescription Date, etc.

Test Result:

Attributes: Test Result ID (Primary Key), Patient ID (Foreign Key), Provider ID (Foreign Key), Test Date, Test Type, Test Result, Notes, etc.

Allergy:

Attributes: Allergy ID (Primary Key), Patient ID (Foreign Key), Allergen Name, Reaction, Severity, etc.

Immunization:

Attributes: Immunization ID (Primary Key), Patient ID (Foreign Key), Immunization Type, Date Administered, Provider ID (Foreign Key), etc.

Document:

Attributes: Document ID (Primary Key), Patient ID (Foreign Key), Document Type, Document Name, Upload Date, Content, etc.

Entity Relationships:

- Each Patient can have multiple Visits, Medications, Test Results, Allergies, Immunizations, and Documents.
- Each Visit is associated with one Patient and one Healthcare Provider.
- Each Medication is associated with one Patient and one Healthcare Provider.
- Each Test Result is associated with one Patient and one Healthcare Provider.
- Each Allergy is associated with one Patient.
- Each Immunization is associated with one Patient and one Healthcare Provider.
- Each Document is associated with one Patient.

Security and Compliance Considerations:

- Implement robust access control to ensure that only authorized users can view and modify patient records.
- Encrypt sensitive patient data to protect it from unauthorized access.
- Maintain audit trails to track all user interactions with patient records.

- Implement data retention policies to comply with legal and regulatory requirements.

This is a simplified example of an EHR database schema. In a real-world scenario, you would need to work closely with healthcare professionals, database administrators, and legal experts to design a comprehensive and secure database schema that meets the specific needs of the healthcare organization and ensures compliance with relevant regulations. Additionally, you may need to consider data storage technologies, scalability, and backup and recovery procedures to ensure data integrity and availability.

CHAPTER 8

PERFORMANCE TESTING

8.1 PERFORMANCE METRICS

Performance metrics for electronic health records (EHR) are crucial for evaluating the effectiveness and efficiency of EHR systems in healthcare settings. These metrics help assess various aspects of EHR usage, from system responsiveness to patient outcomes. Here are some key performance metrics for EHR systems:

System Responsiveness:

Response Time: Measure the time it takes for the EHR system to respond to user actions (e.g., loading patient records, searching for information).

Downtime and Uptime: Track system availability and downtime to ensure high reliability.

Data Accuracy and Integrity:

Data Accuracy: Assess the accuracy of data entry, storage, and retrieval within the EHR system.

Data Completeness: Measure how much of the patient's health record is complete and up to date.

Usability and User Satisfaction:

User Feedback: Gather feedback from healthcare providers and end-users about the system's usability, user-friendliness, and efficiency.

Task Completion Time: Measure the time it takes for healthcare providers to complete common tasks within the EHR.

Interoperability:

Data Exchange: Assess the system's ability to exchange patient data with other healthcare organizations, systems, and medical devices.

Standards Compliance: Check if the EHR system adheres to interoperability standards like HL7 or FHIR.

Data Security and Privacy:

Security Incidents: Monitor and report security incidents, such as unauthorized access attempts or data breaches.

User Access Audits: Review audit logs to track who accessed patient records and what actions were performed.

Clinical Decision Support:

Alert Overload: Measure the frequency of clinical alerts and assess their relevance and impact on patient care.

Adherence to Clinical Guidelines: Evaluate the system's ability to promote adherence to clinical guidelines and best practices.

Medication Management:

Medication Errors: Track and reduce medication errors, including prescribing and administration errors.

Medication Reconciliation: Measure the effectiveness of medication reconciliation processes.

Patient Engagement:

Patient Portal Usage: Monitor patient engagement with the EHR through patient portals, including appointment scheduling and secure messaging.

Patient Access: Evaluate the ease of patient access to their own health records and the ability to share their data with other providers.

Workflow Efficiency:

Task Efficiency: Assess how efficiently healthcare providers can complete their tasks within the EHR, such as charting, order entry, and documentation.

Reduced Administrative Burden: Measure the impact of the EHR on reducing administrative tasks for healthcare providers.

Regulatory Compliance:

HIPAA Compliance: Ensure compliance with healthcare data privacy and security regulations, such as HIPAA in the United States.

Meaningful Use (MU) Criteria: Assess adherence to MU criteria to qualify for incentives and avoid penalties.

Patient Outcomes:

Clinical Outcomes: Examine the impact of EHR usage on patient health outcomes, such as reduced hospital readmissions or improved chronic disease management.

Quality of Care: Measure the quality of care provided, such as preventive care measures and adherence to evidence-based practices.

Resource Utilization:

Resource Allocation: Evaluate the allocation of resources, including time and personnel, to maintain and use the EHR system effectively.

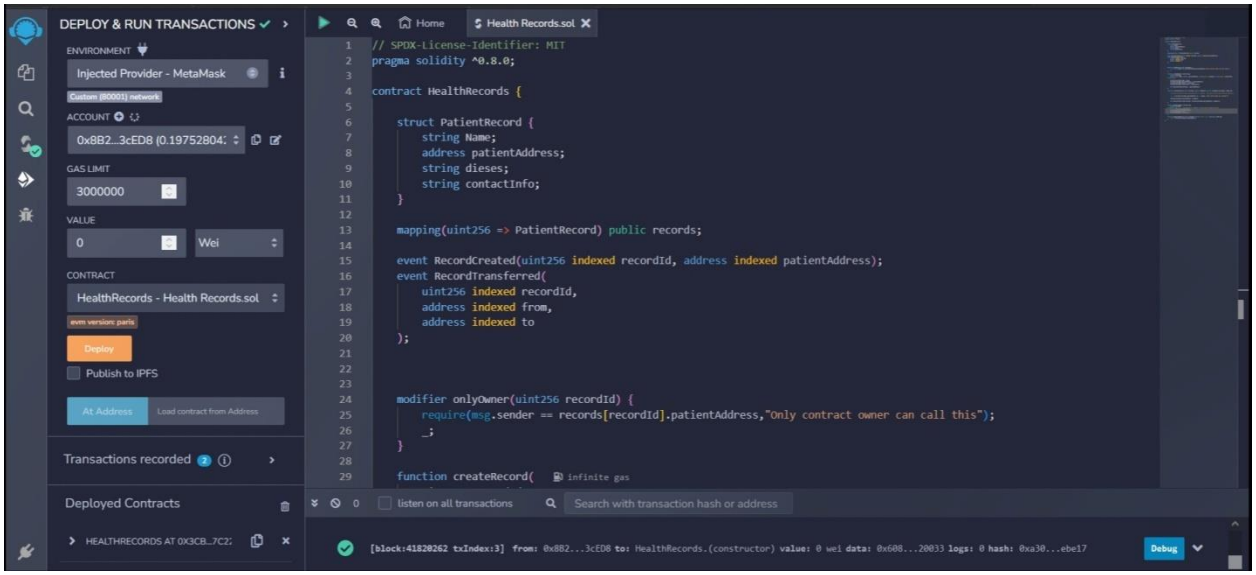
Cost Efficiency: Assess the cost-effectiveness of the EHR system and its impact on healthcare delivery costs.

Performance metrics for EHR systems should align with the goals and objectives of the healthcare organization, including improving patient care, streamlining workflows, enhancing data security, and complying with healthcare regulations. Regular monitoring and analysis of these metrics can help identify areas for improvement and optimize the EHR system's performance.

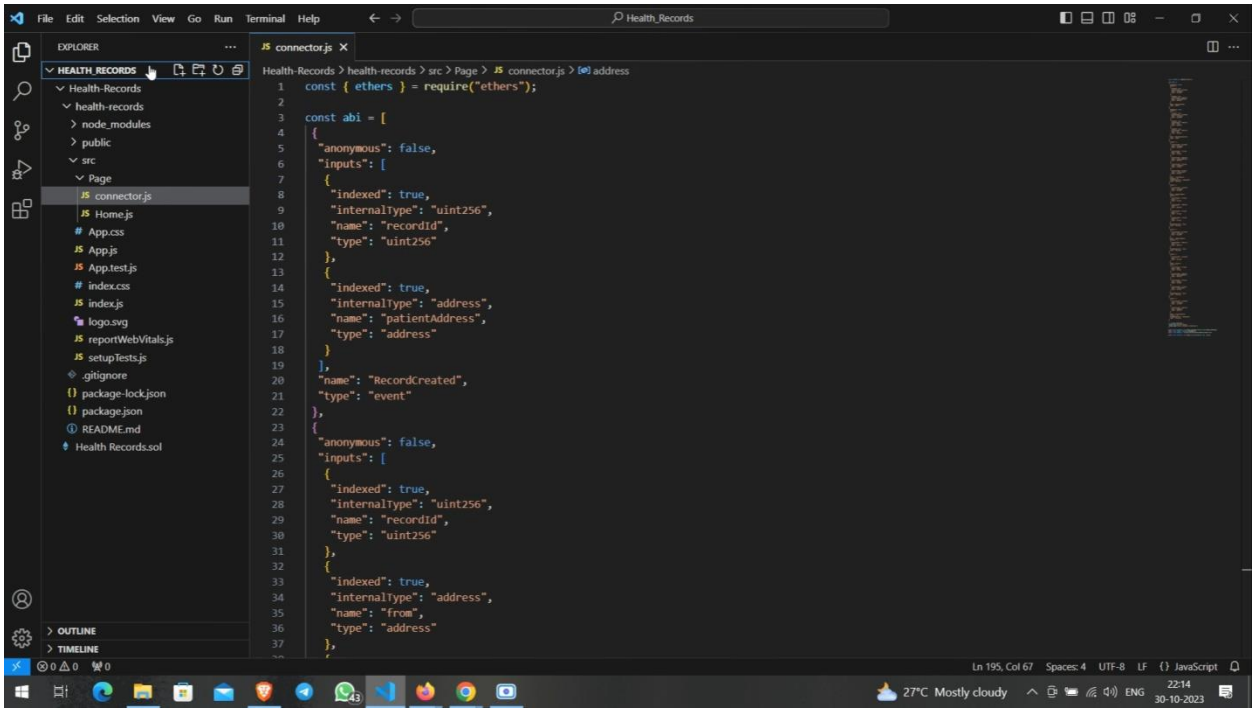
CHAPTER 9

RESULTS

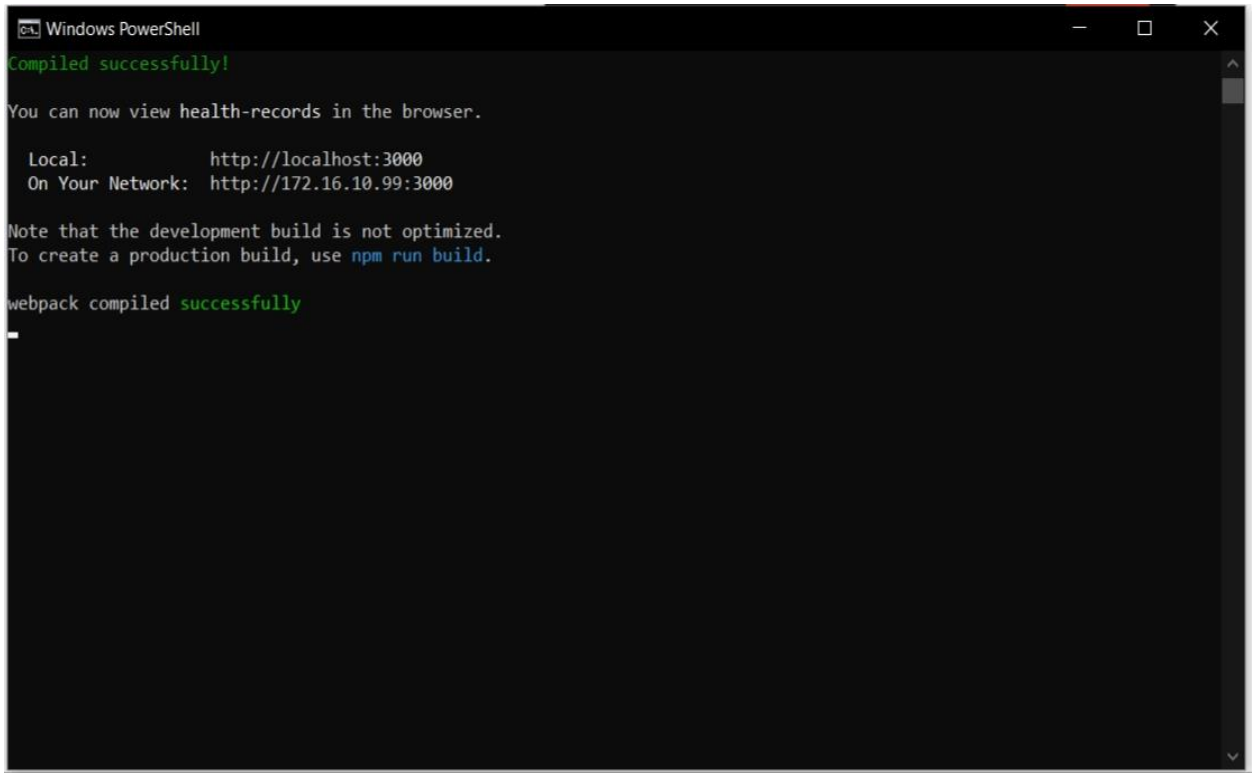
9.1 OUTPUT SCREENSHOTS



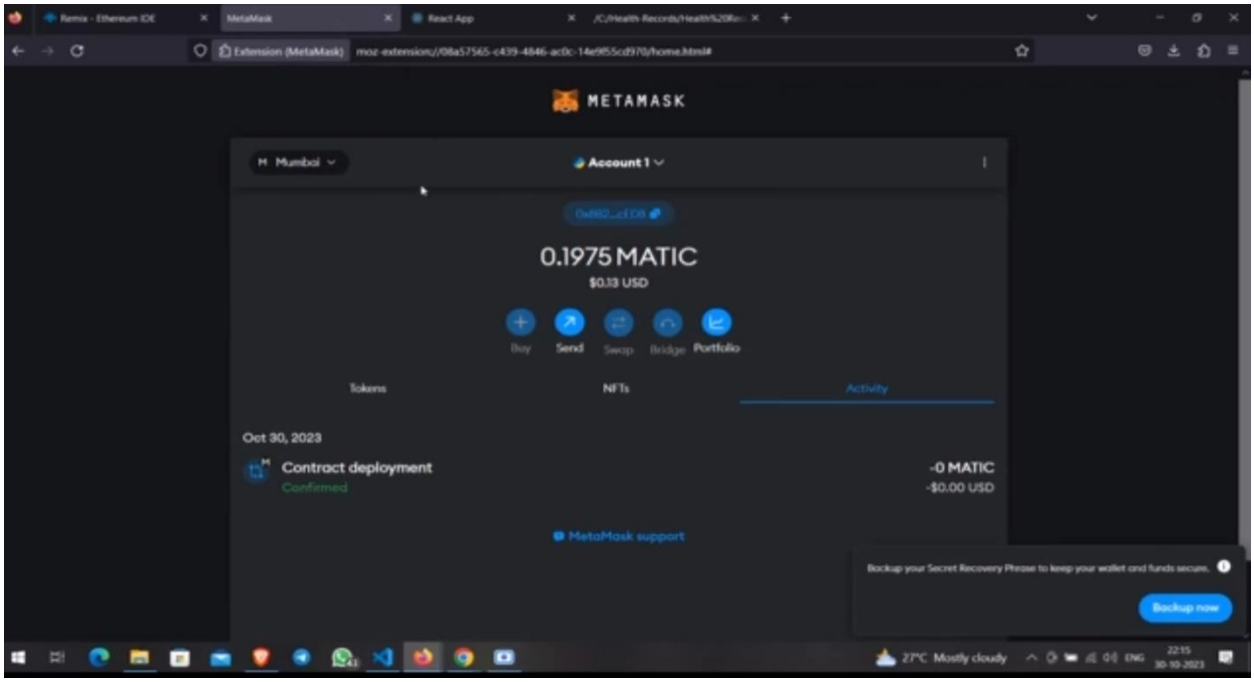
REMIX IDE



VS CODE



TERMINAL OUTPUT



METAMASK

FINAL OUTPUT

CHAPTER 10

ADVANTAGES & DISADVANTAGES

Electronic health records (EHRs) offer numerous advantages and have transformed the healthcare industry, but they also come with some disadvantages. Here are some of the key advantages and disadvantages of electronic health records:

Advantages of Electronic Health Records (EHRs):

Improved Access to Patient Data:

EHRs provide instant access to patient records, allowing healthcare providers to view, update, and share patient information across different facilities and locations.

Enhanced Patient Care:

EHRs enable better clinical decision-making by providing healthcare professionals with comprehensive patient histories, lab results, and real-time information.

Efficiency and Productivity:

EHRs streamline administrative tasks, reducing paperwork and eliminating the need to manually search for paper records. This increases healthcare provider efficiency and reduces administrative burden.

Interoperability:

EHRs support data exchange between different healthcare systems and providers, promoting care coordination and ensuring a more comprehensive view of a patient's health.

Cost Savings:

Transitioning to EHRs can lead to long-term cost savings by reducing the need for physical storage, improving billing accuracy, and minimizing duplicate tests.

Patient Engagement:

EHRs often include patient portals that allow patients to access their health records, communicate with providers, schedule appointments, and monitor their own health.

Clinical Decision Support:

EHRs can provide clinical decision support tools that help healthcare providers with diagnosis, treatment recommendations, and alerting to potential drug interactions.

Remote Access:

Healthcare providers can access EHRs remotely, allowing for telemedicine and more flexible care options.

Disadvantages of Electronic Health Records (EHRs):

Implementation Costs:

Transitioning from paper records to EHRs can be costly due to software, hardware, training, and support expenses.

Learning Curve:

Healthcare providers and staff often face a learning curve when adopting EHRs, which can temporarily reduce productivity.

Data Security and Privacy Concerns:

EHRs raise concerns about data breaches, unauthorized access, and privacy violations. Protecting patient data is a constant challenge.

Interoperability Challenges:

Achieving seamless data exchange between different EHR systems and healthcare organizations can be technically challenging, leading to data silos.

Workflow Disruption:

EHR implementation can disrupt existing healthcare workflows, requiring adjustment and potentially causing temporary disruptions in patient care.

User Burnout:

Prolonged use of EHRs may lead to user burnout, as healthcare providers spend significant time on data entry and administrative tasks.

Legal and Regulatory Compliance:

Maintaining compliance with healthcare regulations, such as HIPAA, is an ongoing and complex task for EHR users.

Potential for Errors:

EHRs can introduce errors due to data entry mistakes, inaccurate information, or reliance on technology for critical decisions.

Data Loss and Downtime:

Technical issues or system downtime can lead to the temporary loss of access to patient data, which can impact patient care.

Overall, the advantages of EHRs, such as improved access to patient data and enhanced patient care, have the potential to transform healthcare delivery. However, the disadvantages, including cost, data security concerns, and workflow disruption, require careful management and ongoing attention to ensure that EHRs provide their full benefits while minimizing their drawbacks.

CHAPTER 11

CONCLUSION

In conclusion, Electronic Health Records (EHRs) have revolutionized the healthcare industry by digitizing patient information and streamlining healthcare processes. The transition from traditional paper records to EHRs offers numerous benefits, such as improved access to patient data, enhanced patient care, increased efficiency, and cost savings. EHRs enable better clinical decision-making, promote interoperability, and empower patients to engage in their own healthcare.

However, the adoption of EHRs also comes with challenges, including high implementation costs, a learning curve for healthcare providers, data security and privacy concerns, and potential workflow disruptions. Ensuring data security and regulatory compliance is paramount, as is addressing interoperability challenges to allow seamless data exchange between different healthcare systems.

The advantages of EHRs hold immense promise for improving patient outcomes and healthcare delivery. While challenges exist, ongoing efforts to address them, including improving usability, data security, and interoperability, can further enhance the benefits of EHR systems. The continuous development and integration of advanced technologies will play a pivotal role in shaping the future of EHRs and the healthcare industry as a whole.

CHAPTER 12

FUTURE SCOPE

The future of Electronic Health Records (EHRs) holds significant promise, with several exciting developments and opportunities on the horizon. Here are some of the future scopes and trends for EHRs:

Artificial Intelligence (AI) and Machine Learning:

EHRs will increasingly incorporate AI and machine learning algorithms to assist healthcare providers in diagnosing diseases, predicting patient outcomes, and providing more personalized treatment recommendations.

Predictive Analytics:

EHRs will leverage predictive analytics to identify at-risk patients, allowing healthcare providers to intervene proactively and improve patient outcomes while reducing healthcare costs.

Block chain Technology:

The use of block chain in EHRs can enhance data security and integrity. It allows patients to have more control over their health data and streamline data exchange between healthcare organizations while maintaining privacy.

Interoperability and Health Information Exchange (HIE):

Efforts to improve interoperability will continue to allow for seamless data sharing between different EHR systems, healthcare facilities, and providers. This will enhance care coordination and reduce redundancy.

Patient-Cantered Care:

EHRs will increasingly focus on patient-centered care, enabling patients to actively engage with their health data, make informed decisions, and collaborate with healthcare providers.

Telehealth and Remote Monitoring:

The integration of EHRs with telehealth platforms and remote monitoring devices will facilitate virtual care, expanding access to healthcare services and monitoring of chronic conditions.

Mobile Access and mHealth:

EHR systems will become more mobile-friendly, allowing healthcare providers to access and update patient data using smart phones and tablets, making healthcare more flexible and convenient.

Genomic Data Integration:

EHRs will incorporate genomic and genetic data, enabling a deeper understanding of a patient's health and the potential for more personalized medicine.

Data Standardization:

Efforts to standardize healthcare data will continue, ensuring that EHRs can exchange information uniformly and effectively.

Quality Metrics and Value-Based Care:

EHRs will play a pivotal role in tracking and reporting quality metrics, which are vital for value-based care initiatives. This will support reimbursement models focused on quality and outcomes.

Population Health Management:

EHRs will assist in managing the health of entire populations by aggregating and analyzing data to identify trends, monitor disease outbreaks, and address public health concerns.

Continuous Improvement and Usability:

EHR vendors will focus on improving the usability and user-friendliness of systems to reduce the burden on healthcare providers and enhance their experience.

Regulatory Compliance and Data Security:

As healthcare regulations evolve, EHR systems will need to adapt to ensure ongoing compliance and robust data security measures.

Research and Innovation:

EHR data will play a crucial role in medical research and innovation, accelerating the development of new treatments and therapies.

The future of EHRs is dynamic, and these advancements hold the potential to significantly improve patient care, reduce healthcare costs, and enhance the overall healthcare experience. The integration of technology, data analytics, and patient-centric approaches will continue to shape the landscape of electronic health records in the years to come.

CHAPTER 13

APPENDIX

SOURCE CODE

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.0;

contract HealthRecords {

    struct PatientRecord {
        string Name;
        address patientAddress;
        string dieses;
        string contactInfo;
    }

    mapping(uint256 => PatientRecord) public records;

    event RecordCreated(uint256 indexed recordId, address indexed
patientAddress);
    event RecordTransferred(
        uint256 indexed recordId,
        address indexed from,
        address indexed to
    );



    modifier onlyOwner(uint256 recordId) {
        require(msg.sender == records[recordId].patientAddress,"Only contract
owner can call this");
        _;
    }

    function createRecord(
        uint256 recordId,
        string memory name, address _patientAddress, string memory _diseases,
string memory _contactInfo
    ) external {
```

```
        records[recordId].Name = name;
        records[recordId].patientAddress = _patientAddress;
        records[recordId].dieses = _diseases;
        records[recordId].contactInfo = _contactInfo;

        emit RecordCreated(recordId, _patientAddress);
    }

    function transferRecord(uint256 recordId, address newOwner) external
onlyOwner(recordId) {

        //require(records[recordId].patientAddress == newOwner, "New Owner
should have different Address");

        require(records[recordId].patientAddress == msg.sender, "Only record owner
can transfer");

        records[recordId].patientAddress = newOwner;

        emit RecordTransferred(recordId, records[recordId].patientAddress,
newOwner);
    }

    function getRecordData(
        uint256 recordId
    ) external view returns (string memory, address, string memory,string memory)
{
        return (records[recordId].Name,
        records[recordId].patientAddress,
        records[recordId].dieses,
        records[recordId].contactInfo);
    }

    function getRecordOwner(uint256 recordId) external view returns (address) {
        return records[recordId].patientAddress;
    }
}
```

App.js

```
import './App.css';
import Home from './Page/Home'

function App() {
  return (
    <div className="App">
      <header className="App-header">
        <Home />
      </header>
    </div>
  );
}
```

Index.js

```
import React from 'react';
import ReactDOM from 'react-dom/client';
import './index.css';
import App from './App';
import reportWebVitals from './reportWebVitals';

const root = ReactDOM.createRoot(document.getElementById('root'));
root.render(
  <React.StrictMode>
    <App />
```

```
  </React.StrictMode>
);

// If you want to start measuring performance in your app, pass a function
// to log results (for example: reportWebVitals(console.log))
// or send to an analytics endpoint. Learn more: https://bit.ly/CRA-vitals
reportWebVitals();
```

Reportweb.js

```
const reportWebVitals = onPerfEntry => {
  if (onPerfEntry && onPerfEntry instanceof Function) {
    import('web-vitals').then(({ getCLS, getFID, getFCP, getLCP, getTTFB }) => {
      getCLS(onPerfEntry);
      getFID(onPerfEntry);
      getFCP(onPerfEntry);
      getLCP(onPerfEntry);
      getTTFB(onPerfEntry);
    });
  }
};
```

Setup.js

```
import '@testing-library/jest-dom';
```

GITHUB & PROJECT DEMO LINK

- GitHub Link: https://github.com/NOELSTAINES/NOEL-.git
- Demolink: https://drive.google.com/drive/folders/1vmZdXcsqZw30gritZoPPHg5WYXFgrQ_f?usp=drive_link