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Integration of Healthcare with Blockchain Technologies - A Feasibility and Requirements Management Study

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1 PROBLEM STATEMENT

The ongoing SARS - CoV 2 pandemic has sent the world into a tizzy. Within a matter of three months, lives have been thrown out of gear. Schools, colleges and workplaces have been shut indefinitely, shops closed except for the essential services. Even as healthcare workers fight in the vanguard to keep us safe, more people have been staying home than ever before, and more importantly, the usage of online services has grown exponentially, ranging from food/grocery delivery to education. As online and cloud services grow, an important question is raised - Are these online services safe?

Though the ease of access and usage provided is unparalleled, the security and integrity risks that come along are substantial. Many people use digital services for everything - ranging from business, education and healthcare. As the stakeholders in cyberspace grow, so do the threats. Especially in the field of healthcare, we need to securely store and transmit medical data of people, and make it accessible to the health organisations only. A niche example would be a typical office environment - the health data of employees has to be collected and saved securely by the organisation, to mitigate whatever risk may be associated. Unfortunately,

accessibility and security don't always go together. They are, in fact, the polar opposites of each other. Recently in Mumbai, over 120 million medical images and scan reports were exposed by computer hackers. This is just one of the many incidents that are happening throughout the state[1]. It becomes clear to us that exposure of private healthcare data is a serious concern. The repercussions are severe. Hence, we propose a solution of Integration of Healthcare with Blockchain Technologies.

In this ever-growing online world, we look for new areas to disrupt and digitize - healthcare is the latest emerging field for digitization. The usage of digital services in healthcare is by no means new; we have already heard of the term telemedicine a decade ago. The pandemic has exposed the vulnerabilities in our healthcare system - in order to prevent such an event from ever happening again, it is becoming increasingly evident that the power of 0's and 1's has to be leveraged. Security threats do exist in the form of hackers, data breaches and identity thefts. All this, and much more can be safeguarded against through the adoption of blockchain technology.

2 What is Blockchain

Blockchain is an open, distributed digital ledger invented by Satoshi Nakamoto in 2008. What started off as a whitepaper a decade ago promises to be one of the forefront leaders of future technology. It is a way of recording information in such a way that it becomes impossible to hack or modify. Blockchain is a growing list of records or blocks that are linked using cryptography. Each block contains a cryptographic hash of the previous block. It is managed by a peer to peer network, thereby leading to a decentralized consensus[2]. It has only grown in popularity since its inception in 2008, and today, it has a wide range of applications, ranging from military to healthcare.

A vital requirement while designing such blockchain healthcare systems are to secure the patients sensitive data. As there are multiple entities involved in the blockchain based healthcare mechanisms, the security should be at the prime focus. Blockchain is expected to ensure more security, privacy and trust as compared with traditional healthcare systems. One of the primary reasons for more privacy and trust is because all the involved entities are aware of all the data transactions within the system.

One of the challenges in current healthcare management systems is the fragmentation and inconsistency of the medical data. Data inconsistency may cause delay and higher costs to complete the overall healthcare process for any user. Therefore, a blockchain based healthcare system must ensure that the healthcare data is consistent and unfeasible to be altered by any unauthorized entities, such as hackers or bad actors.

3 STAKEHOLDERS

1. Company shareholders - The investors of the potential enterprise who help make the project economically feasible.
2. Cloud Service providers - Providers of digital cloud infrastructure for secured data storage which is necessary for operational feasibility.
3. Medical Researchers - The academics and researchers who actively study and experiment on diseases, their causes and effects.
4. Physicians - The medical practitioners who diagnose and prescribe medicines.
5. Patients - Sick people who avail healthcare services.
6. Insurance providers - Companies that provide health insurance services on a subscription model, and reimburse hospital bills.
7. Emergency service providers - Ambulance services and first responders to a medical emergency.
8. Supply Chain Management - The marketing, logistics and sales workforce who handle the procurement and production of medicines and healthcare equipment.
9. Pharmaceutical manufacturers - Companies that manufacture medicines and healthcare equipment technologies.
10. Data Analysts - Researchers who analyse medical data to discover patterns that may help in the early detection and prevention of diseases/epidemics.
11. Government - State funded healthcare projects and schemes, such as the Ayushman Bharat Yojana.
12. Medical Organisations - Global players, like the World Health Organisation, or national bodies like Indian Medical Association.
13. Miners - Independent blockchain miners who help create new blocks and make sure that there are no illegitimate chains.
14. Employers - Employers have their “third-party” intervention reduced as their protocols for providing insurance changes.
15. Personalised Wearable Manufacturers - Many people prefer to have their health data monitored and displayed real time; smartwatches and digital exercise bands provide such services.

4 Feasibility Study

4.1 Legal Feasibility

In the healthcare context, the importance of maintaining patients' confidentiality is clear. Patients must feel comfortable sharing private information about their bodily functions, physical and sexual activities, and medical history. This is information that they would not want widely known because it may be embarrassing or may have negative practical consequences.Some health conditions are stigmatising and, if known, may cause an individual embarrassment or difficulty in interpersonal relations. Therefore, healthcare providers need to keep patients' health information confidential. The proposed blockchain based medical records system is fine tuned to uphold and protect the privacy laws ascertained by the Medical Council of India's Code of Ethics Regulations.

4.2 Economic Feasibility

Any blockchain-based solution should be cheaper and less complex than the traditional physical database system in the long term. It should not be more expensive than non-blockchain solutions either. The system should support millions of people, depending on the country, business size or target group population. Though sustaining and maintaining an online block data system is much cheaper than traditional methods, initial deployments might be expensive, especially for businesses.

4.3 Technical Feasibility

Organizations/Institutions that are planning to employ blockchain technologies need to make sure that they have the necessary amount of resources and infrastructure to deploy these technologies on their platform. If deploying and managing IT infrastructure proves to be a herculean task, institutions still have the luxury of buying a cloud plan from any of the different vendors available on the market, so that they need not worry about managing the infrastructure. All they need to do is manage the data on the cloud and provide access only to the people who are responsible for managing the operations and not fall prey to simple social-engineering attacks. This includes support and service operations available 24/7, incase of any issue in the IT management system like failure of services or upgradation of systems. The organization needs to make sure that the team is ready to handle technical issues that may come along, in a graceful manner.

4.4 Operational/Scalable Feasibility

One of the potential challenges in blockchain healthcare would be scalability. Although solutions for operational extensibility do exist, this integration concept is in its early stages, and the trade-off between the available computing capabilities versus the amount of medical transactions could limit the scalability of such healthcare systems.

4.5 Scheduling Feasibility

Any good implementation of an idea is considered useful to people, only if everyone gets easy access to the solution. If not properly scheduled, it can bring down the whole implementation, thereby rendering the idea useless. The integration of blockchain with healthcare amenities should be scheduled in a feasible way such that people should be able to access it, without having to wait/fight for it. The above stated feasibility examples should be scheduled in an independent manner, so that failure of one entity does not affect the others. Ensuring this is of paramount importance to the stakeholders.

5 Identification of elicitation process for requirements

Blockchain integration with healthcare is an ambitious transformation, with potential to affect virtually every human on the planet. We are going to gather requirements and classify them for each and every stakeholder. A method has to be chosen, such that it suits all of them. The stakeholders are going to be from diverse fields, sometimes not even related in any way. Hence, with this unique impediment in mind, one may choose an interview process to elicit the requirements.

It is a great way of gathering the requirements, and it provides a good platform on which the stakeholder and the analyst can interact to gather requirements. One cannot satisfy the customer without getting to communicate with the customer, and if we follow a one-size-fits-all approach, it is bound to fail. Unfortunately for us, the list of stakeholders is so vast that interviewing each one individually to elicit requirements can become a daunting challenge in itself. If we could interact with all / a major related chunk of the stakeholders at once, it can simplify the workflow and make communication and idea flow much easier. Thus, a better alternative considered is a requirements workshop.

This method becomes efficient with more than a single analyst. More efficient than an interview, it also provides scope for group brainstorming among the participating stakeholders. Domain-modelled artifacts can be used to provide a bird's eye view of the whole domain to all the participants, in a common setting. The major tradeoff considered between the interview method and requirements workshop is time. While interviewing people one-on-one can become time consuming, a requirements workshop provides a faster way to gather requirements. It is well known that a faster/agile model workflow can provide quick results, virtually guaranteeing fast return on investments.

Thus, after much thought and deliberation, we have chosen **Requirements Workshop** as the method to gather requirements. A couple of other requirements elicitation techniques like prototyping were also considered as a part of this project but taking the time and the investment into account, we chose requirements workshop. Certain similar characteristics can be inherited into this technique in order to provide a deep insight on the product. Performing whiteboard description, logic and system design could provide the stakeholders an idea of the internal workings. Since the product heavily relies on blockchain technologies, it's easy to explain it theoretically rather than building a system, so a lot of cost-cutting is involved. So, a series of such workshops conducted over various iterations can ensure that the final product is ready for mission-critical applications.

6 REQUIREMENTS GATHERED FROM EACH STAKEHOLDER

*SF - System functionality *F - Feature

1. **Company shareholders**
   The investors in the enterprise providing the digital solution will be a stakeholder here.
   SF- All units of the software product function properly, Maintain financial records. Since shareholders invest in the company for profits, first and foremost they would want to see a fully functional software product system which is one of the core functionalities.
   F - Apart from that, an in-built ERP system for third party providers for further integration with their respective API's. A tool to maintain financial records for shareholders analysis.

2. **Cloud service providers**
   The providers of digital cloud infrastructure, to secure data storage.
   SF - Provide secure access to the digital cloud.
   F - Platform to access and use the blockchain's distributed ledger

3. **Medical researchers**
   The academicians and researchers who actively study and experiment with diseases, their causes and effects.
   SF - Access to bio-records in a time critical and secure manner.
   F - A system that briefs more about where(from which patient) data came from, rather than an anonymously aggregated dataset, by reading one particular block.

4. **Physicians**
   The doctors who diagnose and prescribe medicines.
   SF - By adding the details of the patient/ the treatment availed, accessing the patients' medical history. Cloud databases can be leveraged for this purpose.
   F - A simple, easy to use and robust interface to access the records.

5. **Patients**
   It can perhaps be the largest segment of stakeholders. The patients avail the healthcare solutions when they are sick.
   SF - Timely and proper access to a healthcare professional, tailored to their disease/ body condition. Data of patients including their history of ailments, diagnoses, prescriptions need to be stored and accessed securely.
   F - Full and unambiguous control over how their data is collected, used and shared.

6. **Insurance providers**
   Companies that reimburse the hospital bills under health insurance schemes, on a subscription based-model.
   SF - Access to the medical record and details of service availed, for seamless reimbursement.
   F- To be able to provide insurance to their clients through the system. They can stamp

the block of the patient, for future prevention against tampering and thus preventing insurance fraud/theft.

7. **Emergency service providers**
   The first responders. Most likely to be ambulance drivers, nurses who administer first aid, and the like.
   SF - They can benefit by having time-critical access to data, so that they do not accidentally perform any action that can endanger the patient to an unrecoverable stage.
   F - The patient's data should be accessible in a safe and secure manner.

8. **Supply Chain Management**
   The various components needed for this system are procured by the marketing, logistics and sales departments. Keeping track of the inventory is a vital part when it comes to healthcare as the demand varies a lot, and performing predictive analysis of the need is difficult. In a time of pandemic, like the one we are experiencing now, demand will always be at a high. So it is highly important to keep the supply upto it and make sure products are reached safely and securely without getting tampered. So, keeping track of the inventory and supply chain along with its third-party partners and distributors is very important and it also needs to be done securely.
   SF- A secure way of accessing the supply chain products on the move as well as in the inventory, so managers can have a real-time statistical view of the supply and demand of the respective products and automate enterprise aspects for the dealers and the retail partners to assess the inventory accordingly. This can prove useful for future sourcing of materials, to reduce the supply deficit gap.
   F - Access to a retrieval system to check with the inventory details.

9. **Pharmaceutical manufacturers**
   Companies that manufacture medicines and healthcare equipment.
   SF - Access to secured medical records and raw material.
   F - Marketing and sales view, where the medical representatives can gain valuable insights into client behavior and consumer attitudes.

10. **Data Analysts**
    Researchers who analyse medical data to discover patterns that may help in the early detection and prevention of diseases/epidemics.
    SF - Secured access to the medical records of all the patients. Access to cloud computing resources for performing analytics and predictability of different diseases and providing a cure.
    F - Provide access and support to a wide variety of open-source libraries and tools, such as MATLAB.

11. **Government**
    State funded healthcare projects and schemes, such as the Ayushman Bharat Yojana. It can also provide afterlife health services as a system functionality and feature. Government, being a central authority, practices absolute control over data and its use. So in such cases, data practices and security needs to be made stringent as a lot of data breach

and misuse takes place. Taking medical records into consideration, it proves to be a much greater threat if the government doesn't regularise the data practices and privacy.
SF - Blockchain technologies that are implemented for secured access and retrieval are made to follow the stringent local/regional government standards and policies.
F - Provide secured access to the government and implement blockchain technologies to securely link accounts like SSN with medical records for faster retrieval of data and medical service provision.

12. **Medical Organisations**
Global players, like the World Health Organisation, or national bodies like Indian Medical Association.
SF - They should be given a common interface / access system through which they can interact and synchronise with all the governments or respective local bodies.
F - A monitoring tool to observe a spike in new diseases/syndromes, thus enabling a quarantine for only that place.

13. **Miners**
Independent blockchain miners who help create new blocks and make sure that there are no illegitimate chains.
SF - Access to cloud GPUs and CPUs, as blockchain mining is extremely heavy in terms of resource consumption.
F - Integrated blockchain mining software, such as ethOS or Hashr8 along with secure crypto wallets.

14. **Employers**
Employers have their "third-party" intervention reduced as their protocols for providing insurance changes. Being an important asset to the company, they play a crucial role in maintaining and hiring new employees.
SF - Access to the medical records of their employees and cross verification using blockchain's unique hash stamps.
F - Integration/tie-ups with insurance agencies for a more comprehensive health insurance coverage.

15. **Personalised Wearable Manufacturers**
Wearable bio-sensors such as blood pressure/ heartbeat monitors. They are commonly integrated into a watch. Smartwatches and digital exercise bands provide such services.
SF - Updating the displayed data in real time to the cloud and performing regular analytics.
F - Reminding users to take good care of health, such as hourly reminders to drink water, and perform other essential activities. Keeping track of the diet that is being followed and adjusting it accordingly to every user. Providing clean and understandable output of medical readings like SpO2, bpm, sugar content and much more.

7 PRIORITIZED REQUIREMENTS IN THREE PHASES

Since all functionalities and features of the product cannot be built and tested in the first product development cycle itself, there is a need to prioritize the requirements based on the criteria of size, importance and dependence. After doing pros and cons comparison for all the requirements mentioned for each stakeholder, the requirement list is divided into three groups - Core Functionalities, Features, and Utilities. Core functionalities are the requirements that are the central focus of the software product itself which will be used by most of the users and stakeholders. Eg. Basic operations of a calculator. Features are the requirements that are important for the software product to implement, as they provide for additional uses and advantages and make the programs easier to use and manage. Eg. Advanced statistical modes Utilities are the requirements that are optional tools to be implemented which are not pivotal but have situational use and importance. Eg. Offering pre built scientific constant values, such as g or pi.

Core Functionalities
In our Blockchain based healthcare system, the core functionalities that have to be offered to the customers is secured data storage and access. To achieve that goal, we have analysed and shortlisted the following requirements that are crucial and critical for the software product to perform its core functionalities properly without bugs and follow a secured security posture.

7.1 PRIORITY 1 - CORE FUNCTIONALITIES AND FEATURES

1. **Shareholders**
   Functionality - Since shareholders invest in the company for profits, first and foremost they would want to see a fully functional software product system which is one of the core functionalities.

2. **Patients**
   Functionality: Timely and proper access to a healthcare professional, tailored to their disease/ body condition. Data of patients including their history of ailments, diagnoses, prescriptions need to be stored and accessed securely.
   Feature - Full and unambiguous control over how their data is collected, used and shared.

3. **Physicians**
   Functionality: By adding the details of the patient/ the treatment availed, accessing the patients' medical history. Cloud databases can be leveraged for this purpose.
   Feature - A simple, easy to use and robust interface to access the records.

4. **Government**
   Functionality - Blockchain technologies that are implemented for secured access and retrieval are made to follow the stringent local/regional government standards and policies.
   Feature - Provide secured access to the government and implement blockchain technologies to securely link accounts like SSN with medical records for faster retrieval of

data and medical service provision.

5. **Cloud Service Providers**
   SF - Provide secure access to the cloud services either as SaaS, IaaS, or PaaS.
   F - Transparency and flexibility for the respective organization that rely on cloud services. Vendors can make sure that clients have the comfort to tailor adjust according to the requirements, and not be limited to its rigidity. Vendors can also provide a platform to access and use the blockchain's distributed ledger.

6. **Supply Chain Management**
   System Functionality- A secure way of accessing the supply chain products on the move as well as in the inventory, so managers can have a real-time statistical view of the supply and demand of the respective products and automate enterprise aspects for the dealers and the retail partners to assess the inventory accordingly. This can prove useful for future sourcing of materials, to reduce the supply deficit gap.

7. **Miners**
   System Functionality - Access to cloud GPUs and CPUs, as blockchain mining is preposterously heavy in terms of resource consumption.

8. **Employers**
   SF - Access to the medical records of their employees and cross verification using blockchain's unique hash stamps.

7.2 Priority 2 - Additional Features

After the core modules are implemented and provided to the stakeholders for discussion, comments and review, the second iteration of developing features can begin. In this stage, other important features are developed that can directly help improve and compliment the core functionalities.

1. **Stakeholders**
   Feature - Apart from that, an in-built ERP system for third party providers for further integration with their respective API's. A tool to maintain financial records for shareholders analysis.

2. **Emergency Service Providers**
   System Functionality - They can benefit by having time-critical access to data, so that they do not accidentally perform any action that can endanger the patient to an unrecoverable stage.
   Feature - The patient's data should be made accessible in a safe and secure manner, so that a lot of time can be saved in gathering info about the patient.

3. **Miners**
   Feature - Integrated blockchain mining software, such as ethOS or Hashr8, along with

secure crypto wallets.

4. **Supply Chain Management**
   Feature - Access to a retrieval system to check with the inventory details.

5. **Insurance Providers**
   Software Functionality - Access to the medical record and details of service availed, for seamless reimbursement.

6. **Employers**
   Feature - Integration/tie-ups with insurance agencies for a more comprehensive health insurance coverage.

7. **Medical Researchers**
   System Functionality - Access to bio-records in a time critical and secure manner.

8. **Data Analysts**
   System Functionality - Secured access to the medical records of all the patients. Access to cloud computing resources for performing analytics and predictability of different diseases and providing a cure.

7.3 Priority 3 - Other Utilities

1. **Medical Researchers**
   Feature - A system that briefs more about where(from which patient) the data came from, rather than an anonymously aggregated dataset, by reading one particular block so that the researcher could perform analysis transparently and assess the respective patient of any guidance and practice.

2. **Data Analysts**
   Feature - Provide access and support to a wide variety of open-source libraries and tools, such as MATLAB and Python. Analysts could save a lot of time by utilising pre-built tools and frameworks rather than building logic from scratch.

3. **Pharmaceutical manufacturers** System Functionality - Access to secured medical records and raw material.
   Feature - Marketing and sales view, where the medical representatives can gain valuable insights into client behavior and consumer attitudes.

4. **Health Organizations**
   System Functionality - They should be given a common interface / access system through which they can interact and synchronise with all the governments or respective local bodies.
   Feature - A monitoring tool to observe a spike in new diseases/syndromes, thus enabling a quarantine for only that place.

5. **Personalised Wearable Manufacturers.**
   System Functionality - updating the displayed data in real time to the cloud and performing regular analytics.
   Feature - Reminding users to take good care of health, such as hourly reminders to drink water, and perform other essential activities. Keeping track of the diet that is being followed and adjusting it accordingly to every user. Providing clean and understandable output of medical readings like SpO2, bpm, sugar content and much more.

6. **Insurance Providers**
   Feature - To be able to provide insurance to their clients through the system. They can stamp the block of the patient, for future prevention against tampering and thus preventing insurance fraud/theft.

8 IDENTIFYING 15 FUNCTIONAL REQUIREMENTS

1. The product must facilitate the storage and retrieval of all healthcare data by the patients.
2. When new users want to register, the portal must cross verify and validate their identities with their Aadhar Cards and send an update to the Government healthcare database systems.
3. The system must provide the functionality of booking appointments through the portal and maintain a log for the same which can be accessed by the patients and doctors.
4. The doctors must be able to modify the details of the patient/ the treatment availed by accessing the patients' medical history using the cloud databases.
5. The prescriptions provided by the physicians must be mapped to the patient's account which can then be accessible to the pharmacies. After the duration is over, further examination by the doctor or extension of the medication should be determined and informed to the pharmacies.
6. All the medicines and related equipment sold by the pharmacies must be updated to the server, and the pharmacies must be able to request for supplies directly to the pharmaceuticals through the system.

7. Real-time access to the performance of the warehouse can help the Supply Chain Management team to execute operational decisions and realign business activities that can ease the process and prevent last-hour rush.

8. Emergency Service Providers must have access to the respective patient's healthcare data at a time-critical situation, so that they do not accidentally perform any action that can endanger the patient to an unrecoverable stage.

9. The system must maintain a log report of all the healthcare personnel who accessed a particular patient's data, and the log must be available to the patient.

10. After any medical expense is recorded on the patient's financial profile, the patient must be able to send the related medical data to ensure reimbursement by the insurance companies

11. Data analysts and medical researchers must be able to access technologies that drive robust statistical and analytical computations using packages or libraries. They should also be given real-time updates on epidemics and tools to model them and give critical updates on the same.

12. The completed analysis of data by researchers must be mapped to existing conditions of patients to help in the recovery process. For example, data pertaining to previous cases of successful treatment of rare diseases should be analysed and sent to doctors who are currently treating similar ailment.

13. Personalised Wearable that is designed for medical purposes must link the data collected to the patient's medical profile.

14. The employers of patients must be able to access specific data from their employees' accounts in order to cover their healthcare plan according to the company's policies.

15. The stockholders and investors of this company must be able to view the outline of the company's performance in blockchain creation and transactions.

9 Identifying 15 Non Functional Requirements

1. Cloud-providers must ensure 24/7 uptime in a secure fashion, to ensure uninterrupted access to the pharmaceutical database and provide a constant data stream to the medical personnel.

2. Load balancing is a vital operation when it comes to efficient distribution of resources and managing huge amounts of traffic congestion, without compromising the network speed.

3. Constant creation of new free data blocks using encrypted hashing techniques in order to keep up with the abundance of new transactions that happen every day.

4. Secure access and faster retrieval is achieved by making use of the blockchain technologies by forming a larger network of trusted individuals operating round the clock, and forming a blockchain that is not easily breakable.

5. To ensure integrity of the infrastructure, regular and standard security audits need to be implemented and any vulnerabilities found must be patched up immediately.

6. As new updates and versions of the software are rolled out, existing features and data should not be compromised or manipulated. Data integrity should be maintained.

7. Organisations like W.H.O, I.M.A should be in a position to communicate efficiently and keep the stakeholders informed, through proper channels and avoiding red tape. They can communicate through a system that integrates all the stakeholders to achieve a more coordinated and synchronized response.

8. This blockchain based system should be integrated with the already existing hospital management systems to allow for smooth transition of data and functions.

9. Government, being a central authority, practices absolute control over data and its use. So in such cases, data practices and security needs to be made stringent as a lot of data breach and misuse takes place. Taking medical records into consideration, it proves to be a much greater threat if the government doesn't regularise the data practices and privacy.

10. In case of a data breach or blockchain double-spending or any other such malpractices, the blocks after said malpractice must be scrutinised and recorded again. The intricate policies of the process should be decided by the miners.

11. Software compatibility should be maintained. Regardless of the type of device or operating system, the system must function without any bugs.

12. The whole environment along with the GUI must be intuitive and trivial so that all users can easily navigate and use the system efficiently with ease.

13. A thorough and detailed documentation of all the modules involved must be written along with easy-to-understand user documentation. As new versions are released, the subsequent delta vision documents must also be released.

14. Forecasting enables warehouses to keep track of sales and anticipated demand, so they can ensure that the available stock is adequate to meet customer needs.

15. Remote technical support and services are provided for the personalised wearables, which greatly reduces the burden of both the patients as well as the support team.

10 IDENTIFYING 5 FEATURES TO THE SYSTEM

1. Integrated blockchain mining software, such as ethOS or Hashr8 along with secure crypto wallets.

2. A simple, easy to use and robust interface to access the records, along with various tools that allows the user to search for data intelligently according to various categories and parameters. Full and unambiguous control over how their data is collected, used and shared is assured.

3. Regular reminders at equal intervals for users to take good care of health, such as reminders to drink water, and perform other essential activities. Providing clean and understandable output of necessary medical readings like SpO2, bpm, sugar content etc.

4. Providing a marketing and sales view, where the medical representatives can gain valuable insights into client behavior and consumer attitudes since forecasting demands may prove to be erratic and unpredictable.

5. Implementing blockchain technologies to securely link digital identity like Aadhar with medical information for faster retrieval of data for medical purposes and also providing secured access to the government.

11 Requirement Management Tool which is most suited for your problem statement

- Aha! is a digital roadmap sharing software. It is offered by the company in the form of Software-as-a-Service.

- The Aha! platform covers not only requirements management, but also provides roadmap, idea capture, and release management among other features. It is based on a portfolio management - type framework. A tool that is most suitable for projects that require planning, prioritizing best ideas, being productive and delivering with real-time content requires a comprehensive tool.

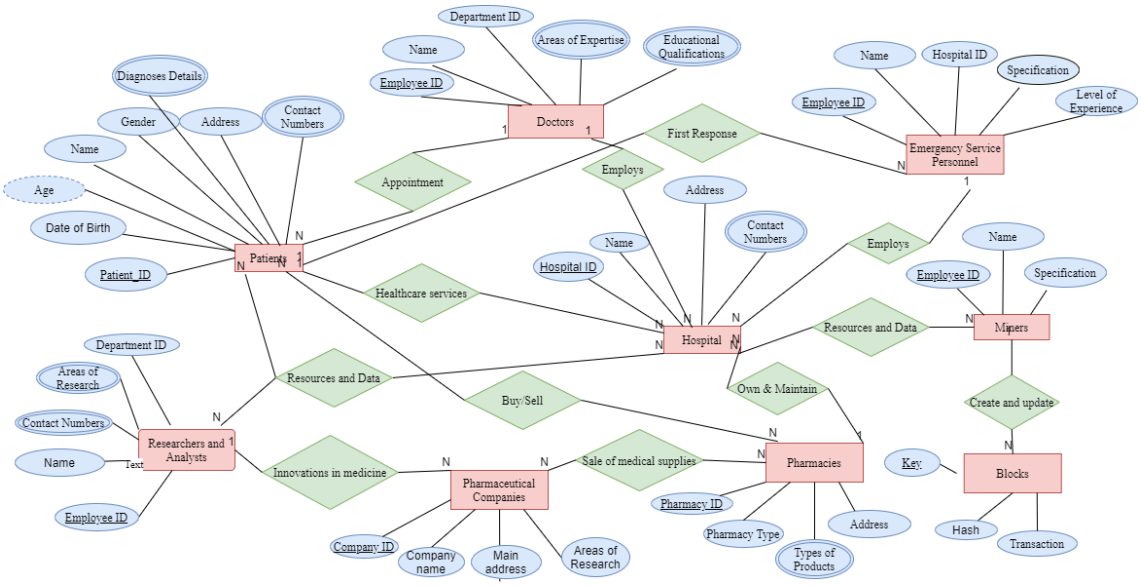
- Our problem statement focuses on the negative aspects of digital interconnectivity of devices to the public internet that are prone to attacks and data breaches. Under such circumstances, tightening up the security posture is crucial for the organization, both in terms of trust and financial stability.And so, implementing blockchain technologies is a better, safer way to record activity and keep data fresh, while maintaining a record of its history. The data can't be corrupted by anyone or accidentally deleted, and you benefit from both a historical trail of data, plus an instantly up-to-date record, thus satisfying Confidentiality, Integrity, Authenticity.

- Aha! provides documenting, analyzing, tracing, prioritizing and agreeing on requirements and then controlling change and communicating to relevant stakeholders. It is a continuous process throughout a project that allows for better control over the workflow.

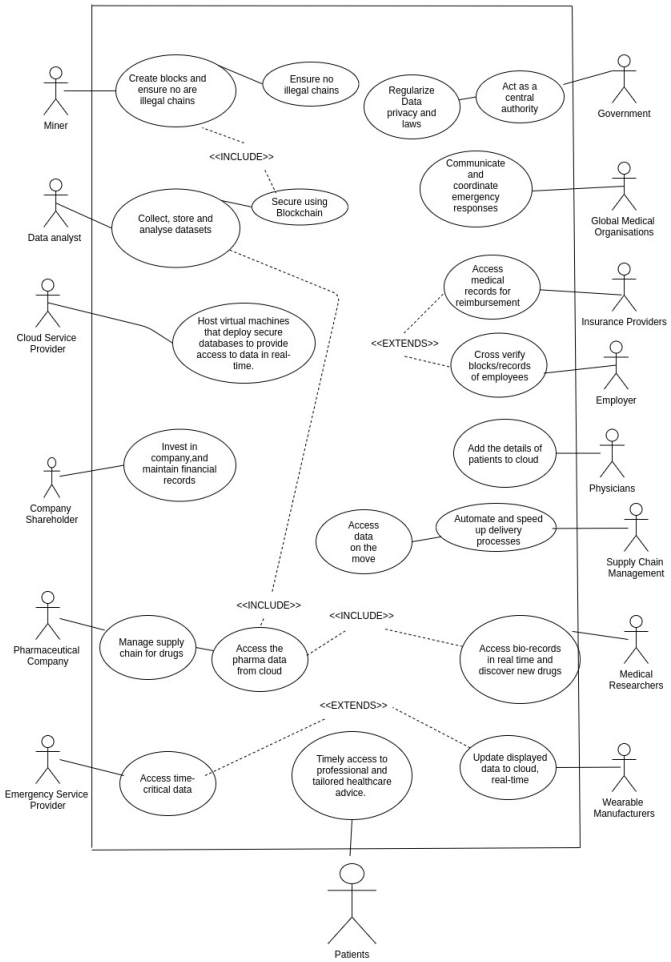
- With respect to our study of integrating healthcare technologies with blockchain, we can say that the healthcare domain has a lot of stakeholders from various other domains

too, we have to elicit the requirements and document the ideas in an easy to interpret manner. Aha! does exactly this, by providing an easy to use interface. Moreover, since it is a mission and time-critical project, we have to continuously improve the product, by pushing regular updates. The updates can be pushed by gathering a set of requirements based on the previous update, or feedback. Aha! provides a method to do so, by setting flags for a variety of activities, ranging from idea/design stage to shipment/delivery stage. So, we can say that such a critical project, which involves multiple stakeholders across various domains, should be updated regularly, and we cannot do so without capturing the requirements properly.

12 Architecture of the System



13 Business Use Case Diagram



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