University in Belgrade
Faculty of Organizational Sciences
Department for e-business

A blockchain system for healthcare

Aleksandra Labus, aleksandra@elab.rs
Miloš Radenković, mradenkovic@raf.rs
Zorica Bogdanović, zorica@elab.rs
Daniel Bjelica, daniel.bjelica@gmail.com
Vukašin Despotović, despotovicvule@gmail.com

Content

- Introduction

- Digital transformation in the healthcare sector

- Blockchain in healthcare

- Blockchain system for healthcare

- Conclusion

Introduction

- Healthcare sector has become increasingly technology focused.

- Innovative technologies such as web and mobile technologies, cloud computing, big data, blockchain, Internet of things, artificial intelligence, virtual and augmented reality have enabled the introduction of modern infrastructure and services in the healthcare ecosystem.

- These technologies can solve problems related to:

  - data management,

  - transparency of business transactions,

  - trust in data handling,

  - security and privacy,

  - scalability and interoperability issues,

  - stakeholder relationship management.

Introduction

- The main goal of this research is the proposition of a blockchain system for healthcare that will enable:

  1. The recording of all data and transactions of healthcare providers, medical laboratories, academia, research institutes and laboratories, companies, health insurance companies and investors, government and state authorities, and patients.

  2. Real-time communication, data sharing between stakeholders, and storing collected data using secure, scalable, and distributed infrastructure.

  3. Managing patients' electronic personal health record, electronic health records, medical reports, electronic prescriptions, health insurance data, and crowdsensing data using blockchain application.

Digital transformation in the healthcare sector

Digital transformation in the healthcare sector

- Digital transformation and Healthcare 4.0 enabled the application of innovative digital technologies in the healthcare sector that positively affected:

  - real-time communication and collaboration among stakeholders,

  - healthcare organizational processes, better productivity, lower business costs,

  - better insight into business transactions,

  - managing large data sets in real-time,

  - health insurance problems,

  - improved medical care services,

  - faster detection and identification of diseases,

  - patients enabling them to approach their medical data and to share them on request with healthcare providers and other participants in the healthcare ecosystem.

Digital technologies in the healthcare sector

- **Internet of things** - enables connecting a large number of various intelligent devices, such as microcomputers, microcontrollers, mobile devices, sensors, actuators, tags and readers, with services and applications on the Internet. Intelligent devices enable monitoring health parameters and can be used in providing telemedicine services.

- **Web and mobile technologies** - enable the exchange of medical data via wireless networks, and management of services in real-time using various web or mobile health applications.

- **Cloud computing** – enables storing, processing and distribution of the collected healthcare data.

- **Big data** – enables real-time analyzing large amount of healthcare data.

- **Blockchain technology** - enables the transparency of transactions in the healthcare ecosystem, the immutability of health data, and safe medical data sharing.

Blockchain in healthcare

Blockchain

- Blockchain represents a method for storing data in a transparent, distributed, and immutable manner.

- It can be defined as a distributed database that contains all recorded transactions in chronological order.

- This distributed database is maintained by a network of verified participants and stores immutable blocks of data that can be shared securely without third-party intervention.

- This concept of storing and sharing recorded data is suitable for the healthcare ecosystem where participants need to be registered members agreed to use a consensus protocol and defined rules.

- Data are preserved and recorded with cryptographic signatures and the use of consensus algorithms.

Blockchain in healthcare

- Blockchain has the potential to improve the healthcare ecosystem to be based on trust, automation, and privacy.

- This could significantly affect on the clinical data exchange between patients, healthcare service providers, pharmacies, insurance companies.

- Blockchain enables safer and more secure access to patients' medical data only by authorized healthcare entities, recording every visit to the healthcare institutions, clinical trials, access to health insurance data.

- If the patient needs healthcare services abroad, doctors can request to approach his electronic health record (EHR) that may include information such as medical history, diagnoses and treatments, laboratory results, and X-ray and MRI images.

- Blockchain should enable the integration of electronic medical reports and create a distributed EHR ecosystem.
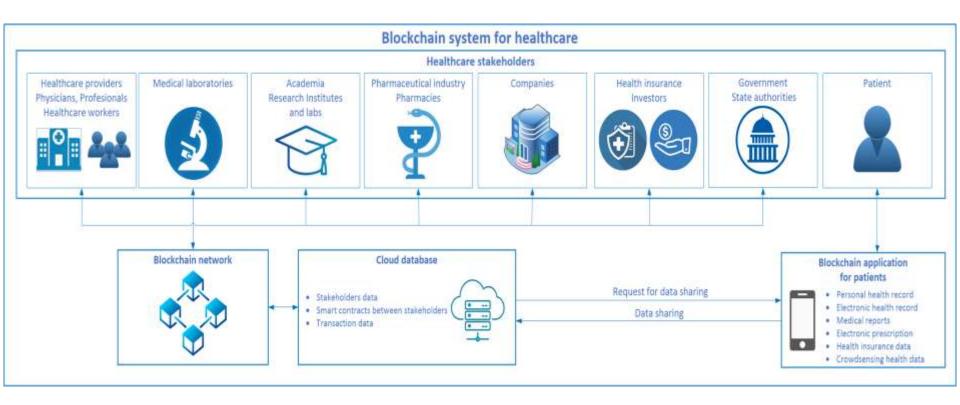
Medicalchain and telemedicine services

- Medicalchain enable patients to exchange medical data with their doctors, share their real-time health data collected using wearable devices, and receive medical advices.

- Wearable devices (such as smart watches, smart bracelets, IoT-based wearable devices, etc.) enable real-time monitoring of temperature, heart rate, oxygen saturation, blood sugar, blood pressure, etc.

- All these data collected via wearables can be tracked using smart healthcare crowdsensing mobile applications.

- Generated crowdsensing data from patient's wearable and mobile devices are stored in the cloud and can be added in the electronic personal health record (ePHR).

Medicalchain and smart contracts

- All health data transactions between patients and doctors, and other stakeholders in the healthcare ecosystem can be tracked using medicalchain.

- All transactions among all participants in the healthcare ecosystem become transparent because of using smart contracts.

- Smart contracts refer to a series of computer codes and protocols that can automatically executed and enforce an agreement when the specified conditions between two parties are met.

- They enable immutability and trustworthiness of blockchain transactions without intermediaries.

Interoperability

- The global medical data exchange is enabled using interoperability.

- The application of interoperability in healthcare:

  - improves operational efficiency,

  - eliminates frauds,

  - reduces the time required for administrative business,

  - reduces medical errors and the duplication of clinical examinations, imaging, or laboratory analysis.

Blockchain system for healthcare

Blockchain system for healthcare

Blockchain system for healthcare

Blockchain system for healthcare

- Blockchain system for healthcare that integrates various services for stakeholders in healthcare sector:

  1. **Healthcare providers**

  2. **Medical laboratories**

  3. **Academia, research institutes and laboratories**

  4. **Pharmaceutical industry and pharmacies**

  5. **Companies and investors**

  6. **Health insurance companies**

  7. **Government and state authorities**

  8. **Patients**

- Healthcare providers can be:

    1. a person (physician, professional, healthcare worker, etc.), or

    2. entity (hospitals, urgent care clinics, health centres, etc.) that provides diagnostic, medical, surgical, or dental treatment, or chronic or rehabilitative care.

- Patient's data are tracked using electronic health record (EHR) system that is part of the providers' existing health information system (HIS).

- Transactions are stored in the blockchain and contain patients' public ID.

- All transactions between healthcare providers and patients are validated and verified using smart contracts.

Blockchain system for healthcare
- Healthcare providers -

- Healthcare providers can record in blockchain all patient's data related to:
  - medical check-ups,
  - immunization dates,
  - established diagnoses,
  - radiology images,
  - allergies,
  - provided medical treatments,
  - laboratory results,
  - prescribed therapies, etc.
- Blockchain also enables storing data related to healthcare provider's transactions with other stakeholders, finance data, data related to business strategies, cooperation agreements, etc.

Blockchain system for healthcare
- Medical laboratories -

- Medical laboratories present a laboratory where patients can test their health.

- Test results are helping healthcare providers to establish a diagnosis and prescribe medical treatment.

- If the laboratory is in the scope of HIS this data will be automatically available to healthcare providers.

- In this way all data medical laboratories can record in the patient's EHR.

- All transactions between medical laboratories and healthcare providers will be recorded in the blockchain.

Blockchain system for healthcare
- Academia, research institutes and laboratories -

- These institutions have a significant role in introducing new medical treatments, diagnostics, medicines and medical equipment.

- Academia contributes to introducing:
  - innovative technologies that improve business in the healthcare ecosystem,
  - new medical equipment,
  - methods of treating the illness.

- Blockchain can be used for recording and sharing all these data among stakeholders in order to all be up to date with science and new practices.

Blockchain system for healthcare
- Pharmaceutical industry and pharmacies -

- In the pharmaceutical industry blockchain can be used for tracking transactions through all supply chain, recording all data related to producing, storing, using medicines, certification, etc.

- All these data will be available to stakeholders via blokchain system.

- Besides data related to medicines, using blockchain system pharmacies can check patients' prescriptions and record transactions about purchased or given drugs on prescription.

- Different types of companies such as corporations, nonprofit companies, startups, individual investors etc. can use the blockchain system and be up to date with new business ventures in the healthcare sector.

- They can invest in:

  - healthcare providers' infrastructure,

  - procurement of medical equipment,

  - development of new medicines, and

  - provide donations for medical treatment of seriously ill patients.

Blockchain system for healthcare
- Health insurance companies -

- Health insurance companies enable insurance that covers all or partial patients' incurring medical expenses.

- Depending on the state, insurance can be in accordance with the law regulating the field of health insurance or private.

- Each insured person has his own personal insurance number.

- Using blockchain health insurance companies can record if the patients' insurance is covered, and share these data with healthcare providers, laboratories and others.

Blockchain system for healthcare
- Government and state authorities -

- Government and state authorities should have authority to track and supervise all transaction in healthcare sector.

- They usually have G2G, G2B and G2C services available via e-government web portal.

- All these transitions among the government and each of the stakeholders in the healthcare sector can be recorded in blockchain.

- Patients can use blockchain applications to approach specific health data that are public in the blockchain.

- In the scope of the application, the patient can have an approach to his:

  1. EHR and preview medical history and reports, electronic prescriptions, health insurance data, etc.

  2. EPHR and record his personal health data collected using different intelligent devices for health monitoring.

- On request, patients can share their identity and data with healthcare providers, laboratories, and insurance companies using the private key.

- All transactions between patients and different participants in the healthcare sector are recorded in the blockchain and stored in cloud database.

Conclusion

Conclusion

- This paper analyses the impact of the digital transformation on the healthcare sector and investigates the opportunities of using blockchain technologies in the healthcare ecosystem.

- The main goal is the proposition of a blockchain system for healthcare.

- The proposed system will enable the recording of all data and transactions of healthcare providers, medical laboratories, academia, research institutes and laboratories, companies, health insurance companies and investors, government and state authorities, and patients.

- All stakeholders' transactions will be done using a blockchain network and all collected data will be stored in a cloud database.

- The proposed system could serve as a good basis for the adoption of blockchain for healthcare in different countries.

Future work

- In the future, it is planned to examine the readiness of the introducing the proposed system in the healthcare sector in the Republic of Serbia.

- The examination will be conducted using the surveying method.

- Projecting blockchain services will be adapted according to identified users' needs.

- As a proof of concept, the proposed system will be implemented as a pilot project using a specific blockchain network.

- Patients will have a blockchain application that will enable managing:
  - electronic personal health record and electronic health records,
  - medical reports and prescriptions,
  - health insurance data,
  - crowdsensing data,
  - etc.

University in Belgrade
Faculty of Organizational Sciences
Department for e-business

A blockchain system for healthcare

Aleksandra Labus, aleksandra@elab.rs
Miloš Radenković, mradenkovic@raf.rs
Zorica Bogdanović, zorica@elab.rs
Daniel Bjelica, daniel.bjelica@gmail.com
Vukašin Despotović, despotovicvule@gmail.com