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ДИГИТАЛНА ТРАНСФОРМАЦИЈА НА ПРИМАРНАТА ЗДРАВСТВЕНА ЗАШТИТА СО КОРИСТЕЊЕ НА БЛОКЧЕЈН ТЕХНОЛОГИЈА

АПСТРАКТ: Дигиталната трансформација во здравствените услуги има огромен потенцијал да обезбеди квалитет на здравствена заштита, еднаквост и пристапност, особено во земјите во развој. Земјите од Западен Балкан не се исклучок од овој тренд на дигитализација и дигитална трансформација. Примарната здравствена заштита како суштински дел од сите здравствени системи има постојана потреба од дигитална трансформација. Блокчејн е интересна област за истражување и разни индустрии ги користеа придобивките што ги дава. Здравствениот систем има огромни придобивки од блокчејн технологијата како резултат на безбедноста, приватноста, доверливоста и децентрализацијата. Во овој труд предлагаме модел на примарен здравствен систем заснован на дигитална трансформација со употреба на блокчејн технологија.

КЛУЧНИ ЗБОРОВИ: здравство, дигитална трансформација, блокчејн, примарно здравје, општ лекар

IMPACT OF SAFE CLIMATE FACTORS ON THE SAFE BEHAVIOR

ABSTRACT: Digital transformation in healthcare services has huge potential to ensure healthcare quality, equality, and accessibility, in particular in developing countries. Western Balkans countries are not an exception to this trend of digitalization and digital transformation. Primary healthcare as an essential part of all healthcare systems is in continuous need for digital transformation. Blockchain has been an interesting research area, and various industries have used the benefits it provides. The healthcare system has huge benefits from blockchain technology due to security, privacy, confidentiality, and decentralization. We propose a model of the primary healthcare system based on digital transformation using blockchain technology.

KEY WORDS: healthcare, digital transformation, blockchain, primary health, general practitioner

ИНФОРМАТИКА

INTRODUCTION

The rapid development of information and communication technologies, together with recent COVID 19 pandemics, pose new opportunities and challenges in the development of the healthcare sector. This is especially important for primary healthcare physicians as the first defense line of healthcare protection. Also, the development of medical technology is providing better healthcare for humanity across the world, although the investment costs are a quite big concern for all governments, healthcare providers, and patients [1]. The advances in medical and mobile technologies offer immense improvement possibilities and can revolutionize the healthcare industry, especially in primary healthcare.

Transformation of traditional business models into a digital model involves all aspects of the business starting from digitization of the processes via usage of digital technologies in products [2]. The processes of digitalization and digital transformation involve changes in the core business operations and mobile services and processes, as well as organizational structures [3]. All this offers many possibilities and challenges in particular in healthcare.

General practice and general practitioners play a central role in every healthcare system. Precisely for these reasons, the digitalization and digital transformation of primary health care is a significant activity and challenge for many health authorities.

The main goal of this paper is to present primary healthcare for authentication and data exchange based on digital transformation using blockchain. In Section 2 we explain the background and related work in Primary health area, while Section 3 elaborates proposed system model. Section 4 summarizes the technical challenges related to authentication, trust and access control of proposed system. Section 5 concludes the paper.

1. BACKGROUND AND RELATED WORK

The need for better healthcare services and the development of information and communication technologies with new achievements in medical technology, create possibilities for improvement of healthcare on all levels. General practice is a synonymous with primary care and family medicine and usually referred to the general practitioner and other personnel [4]. There exists a critical link in primary healthcare between the general practitioner or primary care physician, while the notion of family medicine originally encompassed the mode of a team approach. The primary health care (PHC) approach had started with the Declaration of Alma Ata in 1978, and since then it is strongly advocated internationally continuing to shape many healthcare systems worldwide [5, 6].

Due to the aging population and reductions in the general practitioner (GP) workforce, physicians from general practices have been facing ongoing workload pressures. Consequently, this results in decreasing the access to primary care services that implies serious problems and leads to a high levels of dissatisfaction [7, 8].

The development of technology and its rapid expansion offers various solutions and creates new ideas that would lead to improvements in the healthcare sector. A transformation within the organizations is implied, meaning to transform traditional business models into a digital mode of work. The changes in the core business operations which are caused by digitalization and digital transformation, inevitably cover the field of health care. Digitalization and digital transformation provide a new perspective on decision-making processes by creating an infrastructure for the health data

and they facilitate the establishment of the system for data discovery in databases, Data Warehousing (DW), Business Intelligence (BI) [9].

Many definitions of digitalization and digital transformation can be found in the literature. For the purpose of this paper, we will just use some of them.

Digitalization refers to the use of digital technologies in the context of the production and delivery of services or products. Also, it refers to enabling, improving, or transforming business processes by leveraging digital technologies and digitized data [10]. These digital technologies allow improvements in organization, producing and delivering of healthcare services. We might say that digitalization is rather an organizational and cultural process than a technical one. It means using digital technologies into changing a business model and providing new revenue.

Digital transformation represents a process of exploring digital technologies and supporting capabilities to build an innovative digital business model in order to add business values, and it concerns the process of full integration of digital technologies into an organization's business [10, 11].

In this context, Gartner Inc. in 2018 [16] introduced a new term for digital transformation. According to Gartner, digital transformation represents "Digital business transformation that represents the method of manipulating digital technologies and supporting capabilities to build a robust new digital business model". However, digital transformation shall not be confused with Business Process Reengineering (BPR). Namely, digital transformation obtains and utilizes new data to reimagine old, rule-based processes and turn them into innovative business models and operations, while BPR focuses on automating assigned role-based processes.

Digitalization and digital transformation improve public administration functions and business processes in the healthcare area [12]. With these improvements, digitalization and digital transformation facilitate the realization of the right to health insurance and general healthcare, involves optimizing costs, and provides better healthcare services [13].

Within the process of digitalization and digital transformation, Blockchain technology can offer a solution that helps to securely store and share medical and healthcare data. Also, it can assure the confidentiality of each patient's data provided, as well as their medical and health data ownership [14]. Blockchain technology redefines the data modeling and its governance, deployed in many healthcare applications. Many current ongoing development projects in healthcare have exactly the blockchain technology playing a central part in the processes of digitalization and digital transformation [15].

2. SYSTEM DESIGN

Digital transformation is a complex challenge, but its integration with blockchain simplifies the process as such. Considering the number of partners in primary healthcare (internal, external, or both) involved in any need for healthcare or service provided, a system in which a multitude of electronic parties can securely communicate and collaborate in the administrative processes and transact without human intervention, would be highly agile and efficient. Blockchain technology can holistically manage steps and relationships where participants will share the same data source, such as privacy concerning and transactions connected to each step, while security and accountability is factored in, as well as compliance with general data protection regulations along with internal rules and processes. The result is consistency, reductions in costs and time delays, improved quality, and reduced risks of all kind.

ИНФОРМАТИКА

Blockchain technology offers many possibilities for integration with digital transformation. It can provide many benefits in healthcare, especially for the primary healthcare level. This section introduces a system design of our proposal for a blockchain model for usage in primary healthcare physicians (general practitioners). Our proposal is based on the introduction of blockchain technologies as a technique for the digital transformation of primary healthcare. In particular, we give a proposal of a model for primary healthcare physicians in which databases (or applications) are distributed. Due to the distributed structure of information systems in primary health care, which is the subject of our paper, we would use the approach introduced by Hang et al. [16] in their proposed medical blockchain platform.

The proposed model is constructed on a decentralized network, which connects all primary healthcare providers, including policlinics, Health Insurance Fund, and healthcare corporates. The proposed blockchain network contains peer nodes of different sizes depending on the number of primary care physicians in that primary healthcare office and number of other staff as well. The network model is shown in Figure 1, in which we propose to use a trusted Certificate Authority (CA) for employing certificates and validating public keys.

It contains two sub-networks: a blockchain service network and an authentication service network, which store different types of information derived from primary healthcare data [16].

The resources of a node's peers are divided into three modules: blockchain service, authentication service, and primary healthcare database (PHDB). The servers in blockchain infrastructure maintain a complete blockchain for verifying data integrity and auditing activities. The authentication server maintains the inventory of user healthcare data, maps them to the actual location of storage, and manages sessions.
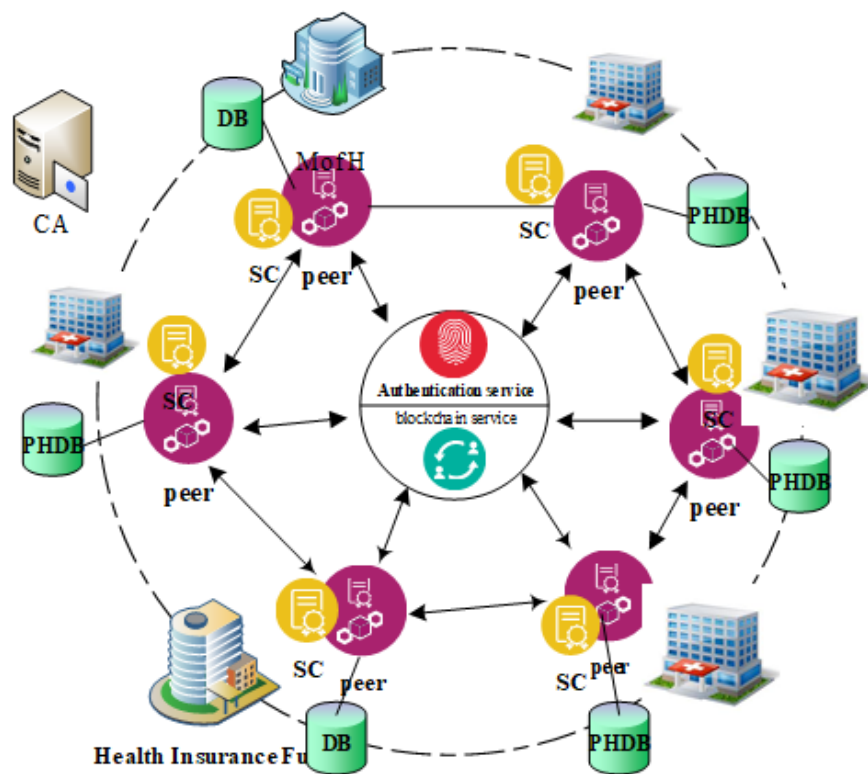

Figure 1: Proposed primary healthcare blockchain platform

The servers of the node-peers form two subnetworks (Blockchain network and Authentication network). Blockchain and Authentication networks connect with Blockchain and Authentication services from the blockchain, while PHDB stores the primary healthcare data of patients. Our model does not require the primary healthcare provider to migrate the existing data to the new system. Instead, it provides to store data locally or for some of the data, it provides the reference to the data in the legacy system for access. All this can reduce the difficulty of adoption, since most primary healthcare providers are reluctant to migrate their data to a new platform.

In our proposed system, the smart contract plays a vital role in performing the agreement among various stakeholders involved in the primary healthcare system. By code's development it can be created a smart contract that defines an agreement signed by the various stakeholders such as a patient, a nurse, or a physician. A smart contract has functions that are considered as a trusted distributed application that gains its confidence from the blockchain and the consensus among the peers. For example, depending on their role, participants can create, update, and query their personal healthcare information by submitting transactions to the smart contract. Some of the commercial blockchain platforms are based on smart-contract, ranging from permissionless platforms such as Ethereum to permissioned platforms such as Quorum, Hyperledger Fabric, and R3 Corda [17]. To implement the proposed system architecture (model), we suggest the usage of smart contracts from Hyperledger Fabric, called chain codes, for implementing the logic application

All participants in our system (patients, nurses, physicians) are required to register in the trusted service offices by providing personal details (such as ID, Biometrics, and PIN), together with the own public key. Since the registration process is a one-single time process, stakeholders submit their details using their mobile devices or web application. Stakeholders' identity registration and enrollment process are shown in figure 2.
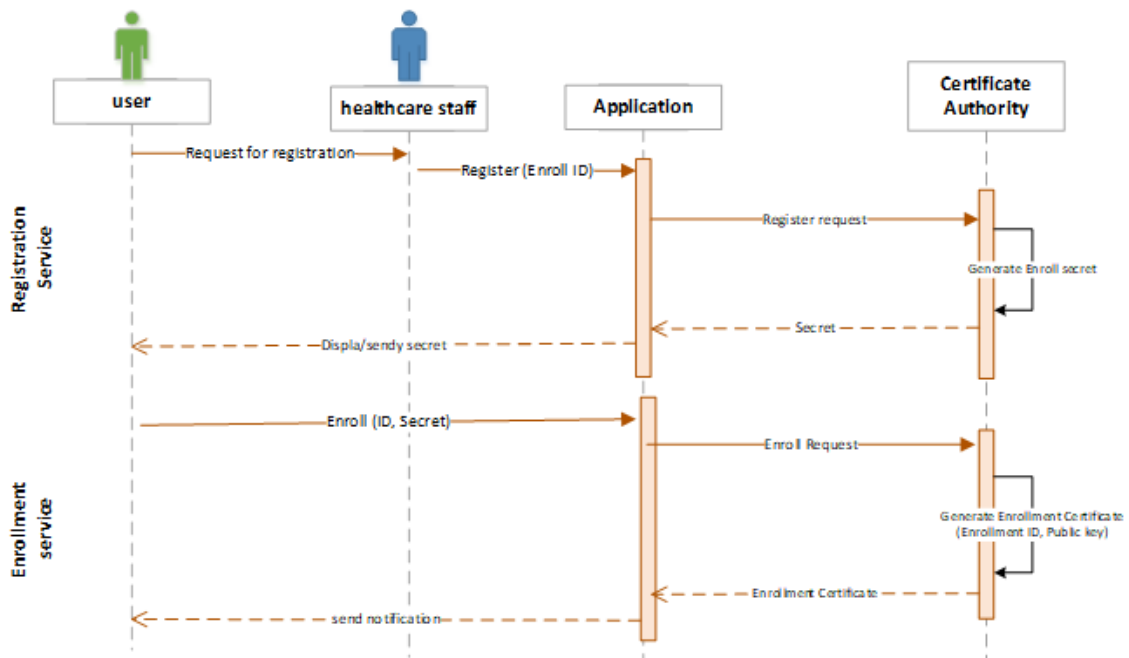

Figure 2: Registration process of users

3. EVALUATION AND DISCUSSION

The aim of this paper was to provide a model for primary healthcare based on blockchain technology, as one of the newest technology for digital transformation. With the aim to identify potential benefits of the previously described architecture based on digital transformation for primary healthcare and provided for organizations and other stakeholders, the analysis must produce several broad clusters. Some of them are:

» impact of the adoption of digital transformation on operational efficiencies and resilience of institutions
» organizational key attributes and managerial implications
» workforce practices
» socio-economic factors

However, the practical implementation of digital transformation based on blockchain technology in healthcare applications and especially in primary healthcare applications is still untested. Future work would lead towards implementation of a functional system of the proposed architecture. Further steps would include: implementing and testing the system architecture in a closed environment, developing and testing most of the system's components and their connection with outsourced components, demonstrating the system's upscaling, and finally going towards actual implementation.

CONCLUSION

Digital transformation of the primary healthcare system comes not only with the implementation of new technologies, but healthcare organizations also have the opportunity to improve existing processes which will influence the increase in the quality of health care provided.

The core focus of the paper is on the theoretical design of a secure and efficient data access mechanism for the current primary distributed primary healthcare system, using digital transformation based on blockchain technology. The proposed system framework model can be used by those healthcare systems which are distributed in their nature, like for example systems in western Balkan countries.

Healthcare institutions that embrace digital transformation will be able to provide a better healthcare via much more consistent workflow, but also more streamlined operations and value-added services. Moreover, they will be able to gain a competitive advantage as well. Higher quality of healthcare services results in a higher quality of life for its users. Digital transformation of the healthcare system by using blockchain technologies has a positive impact for all involved in the system, creates multiple beneficial effects within the service, and finally increases the the satisfaction of the user and its quality of life.

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