Digitalization of Healthcare: Applications and Gains

Sağlık Hizmetlerinde Dijitalleşme: Uygulamalar ve Kazanımlar

ABSTRACT

As in most sectors around the world, there is a digital transformation in the field of healthcare. This transformation aims to reduce costs in the provision of health services, prevent diseases, and minimize human errors in the field of medicine and health financing. The most popular digital tools that serve these purposes are artificial intelligence technologies, big data analytics and blockchain technology. In this context, in this study entitled "Digitalization of Healthcare: Applications and Gains", the achievements in the healthcare sector thanks to these technologies were evaluated. In addition, the risks brought by the digitalization process in the health sector are emphasized and some suggestions are presented to eliminate these risk factors. With the widespread use of artificial intelligence applications in healthcare, the questions that have emerged regarding the privacy of personal information have been resolved within the scope of application examples from different countries. At this point, the advantages provided by blockchain applications such as MedRec, MedChain, MyPCR, FHIRCain, HealthChain, MediBchain, ModelChain, BlockchainHealth, eHealthWallet and Medvault and the areas of use of these applications other than the storage of personal health records have been evaluated. This study is important in terms of shedding light on decision makers in the process of integration of countries' health systems into the digital platforms.

Keywords: Health Economics, Digitalization in Healthcare, AI in Health.

JEL Classification Codes: I10, I11, I19.

ÖZET

Dünya çapında çoğu sektörde olduğu gibi sağlık alanında da dijital bir dönüşüm söz konusudur. Bu dönüşüm ile sağlık hizmetleri sunumunda maliyetlerin düşürülmesi, hastalıkların önlenmesi, medikal alanda ve sağlık finansmanı alanında insan hatalarının minimize edilmesi amaçlanmaktadır. Bu amaçlara hizmet eden en önemli araçlar yapay zeka teknolojileri, büyük veri analitiği ve kişisel sağlık kayıtlarının güvenilir şekilde depolanması hususunda öne çıkan blok zincir teknolojisidir. "Sağlık Hizmetlerinde Dijitalleşme: Uygulamalar ve Kazanımlar" isimli bu çalışmada söz konusu uygulamalar sayesinde sağlık sektöründe elde edilen kazanımlar değerlendirilmiştir. Bununla birlikte sağlık sektöründe dijitalleşme sürecinin beraberinde getirdiği risklerin üzerinde durularak, bu risk unsurlarının bertaraf edilebilmesi için bazı öneriler sunulmuştur. Sağlık hizmetlerinde yapay zeka uygulamalarının yaygınlaşması ile kişisel bilgilerin mahremiyetine ilişkin ortaya çıkan soru işaretlerine, farklı ülkelerdeki uygulama örnekleri kapsamında çözüm getirilmiştir. Bu noktada MedRec, MedChain, MyPCR, FHIRCain, HealthChain, MediBchain, ModelChain, BlockchainHealth, eHealthWallet ve Medvault gibi blok zincir uygulamalarının sağladığı avantajların üzerinde durulmuştur. Bununla birlikte blok zincir temelli uygulamaların kişisel sağlık kayıtlarının depolanması haricindeki kullanım alanları da değerlendirilmiştir. Bu çalışma ülke sağlık sistemlerinin dijital düzleme entegrasyonu sürecinde karar vericilere ışık tutması açısından önem arz etmektedir.

Anahtar Kelimeler: Sağlık Ekonomisi, Dijital Sağlık Uygulamaları, Sağlıkta Yapay Zeka

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INTRODUCTION

The aging of the population and the increase in chronic diseases, changing the expectations of individuals and the ongoing increase in financial constraints in general put pressure on the healthcare sector to seek new ways to provide services at lower costs. While healthcare institutions manage increasing costs, they must also ensure access to reliable and quality healthcare services. In line with developing technology, digitalization is the most important tool for important actors in the healthcare sector to achieve the goal of improving patient experience and responding to needs as quickly as possible by lowering costs, achieving sustainable profitable growth and obtaining competitive advantage.

Digital applications in the health sector are applications that allow the individual to control person's own health status, emphasize preventive health activities, and enable communication between the individual and the healthcare professional. Wearable technologies, virtual reality, tele-medicine, mobile-medicine, e-health, 3D printers, artificial intelligence (AI) are the main digital health technologies and applications.

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Digital technologies have a great importance in increasing accurate information sharing, shortening the drug and material supply process, ensuring transparency and providing the right care service to the right person.

The use of information and communication technologies in the diagnosis and treatment of diseases, as well monitoring the health and risk situations of those who are not sick and monitoring social health, forms the basis of digitalization in health. However, solutions can be found to many problems that arise during the financial management process. In this context, it is very important to integrate the healthcare system such as health research, drug supply, information management, medical practices, preventive services and billing processes into the digital plane. AI technologies used in this direction, blockchain-based applications and big data analytics of obtained from different applications are leading examples of digitalization.

One of the most important issues that should be emphasized in the process of digitalization of healthcare services is the privacy of personal health records. Unlike other fields, digital transformation in healthcare is of much greater importance as it concerns the human generation. Although patients and healthcare professionals are the main actors in this field, medical companies, pharmaceutical companies and technology companies have started to have more determining roles in healthcare systems. At this point, it is of great importance not to share medical data with elements other than patients and healthcare professionals and to protect data during digital healthcare (Lupton; 2013:257). In this context, studies have recently been carried out to reliably store personal health records with the support of blockchain-based applications. In addition to the use of blockchain-based applications for storing personal data, there are also suggestions for minimizing human errors in billing processes, crisis management during pandemics, solving the problem of asymmetric information in private health insurance and reducing costs in the pharmaceutical supply chain.

In this study, first of all, the gains obtained with the use of artificial intelligence and big data analytics are evaluated in the health sector. After that, the question marks arising with the widespread use of these applications are clarified within the scope of blockchain-based applications.

USE OF ARTIFICIAL INTELLIGENCE IN THE HEALTH SYSTEM

The most important and widely influential technology is artificial intelligence in today's digital technology revolution. Artificial intelligence is a major innovative development that can work like a human, think like a human, speak and recognize other living things, recognize the shapes of objects, solve problems, learn, teach and plan.

It is clear that AI technologies will be a significant determinant in the field of medicine/health in the process of digitalization in the healthcare sector. Apart from the increase in the number of robot surgeons, the tremendous innovative devices and systems in medical technologies have paved the way for the development of personalized medicine/health applications and health methods. In addition, the role of new AI-based digital technologies in diagnosing diseases is rapidly increasing. The ability of the artificial intelligence software program of the Swedish company Sophia Genetics to diagnose various genetic-based diseases by reading the genetic codes of DNA is among the clearest examples of this (Büyükuslu, 2014:31). In particular, the widespread use of AI-supported personalized health services will significantly increase effectiveness and efficiency. In this way, effective planning and implementation of health policies will also provide a great advantage in pricing. When the right investments are made by targeting machine usefulness, the skills of nurses and other healthcare personnel can be significantly improved. Great benefits can be achieved particularly in primary health, preventive medicine and low-tech medical applications (Acemoğlu-Johnson, 2023:307).

Today, interest in smart devices that permanently record every step people take, their heart rate, sleep quality and similar information is increasing day by day. These records can be combined with other trackable data to identify possible hidden health risks. For example, chronic insomnia and high heart rate may point out to heart disease risk. When patients are directly involved in the maintenance of their own health, they track certain health trends and transfer them to the cloud where doctors can monitor, allowing them to become a little more independent and save unnecessary doctor visits.

On the other hand, early precautions can be taken for diseases thanks to the participation of individuals in the process with AI applications. The ability of AI to prevent diseases by using key performance indicators is much better than implementing treatment plans after the symptoms of the disease is visible. This system, which can be used to reduce the cost of hospital care, continuously collects patients' health data through wearable devices used outside the hospital and directs them to a cloud. Thanks to real-time alerts, institutions and the maintenance department monitor this massive data and can react in any situation as the results are disturbing. For example, if a

dose of blood pressure rises in a way that causes concern, the system sends a live alert to the doctor and measures are taken to lower the pressure and to carry out the doctor's treatment.

One of the most important gains of AI technologies in the healthcare sector is that it minimizes human errors. Fraud in the healthcare industry is plagued with disruptions, from inaccurate billing to extensive inefficiencies with tests going blank and even adding false information to a person's treatment records. It is stated that approximately 10% of total healthcare expenditures in the USA occur due to fraud or human error (NHCAA, 2023). However, the biggest concern in such disruptions is not money, but the risk in patients' lives. If a person is given the wrong medication or treatment, it is possible for it to last for a long time and result in death. To prevent this, they can analyze prescription patterns used to detect prescription errors before they occur. This capability ensures significant reduction in expenses and more qualified treatment plans.

Also, health and social security expenditures constitute the most important item in public budgets of countries today. Effective utilization of digital technologies such as big data, AI and blockchain will provide states with a great advantage both in the diagnosis and treatment of diseases and in the effective and efficient use of resources. At this point, it is important to evaluate examples of the use of AI in health.

The use of AI in medicine has become widespread worldwide in recent years. A study conducted by the Centerstone Institute in the USA has shown that AI is much more cost-effective in diagnosing patients than traditional diagnostic methods. The physical data and disease results of approximately 500 patients selected by sampling method were analyzed with AI. When the results obtained from the study were evaluated in terms of unit cost, it was concluded that the cost of the transactions made with AI applications to the institution was 189 dollars, while the transactions reached a cost of 497 dollars with the use of traditional methods (Mesko, 2017: 175-180). Watson is an AI program developed by IBM. It is designed to answer questions, to access and examine all health records of patients and scientific publications in this field with machine learning, data mining and natural language processing features. Using this technology, it was found that the treatment recommended by the Watson oncology system for 638 patients with breast cancer in India was 90% similar to the treatments recommended by the tumor detection board working in this field. This resulted in a significant reduction in time and transaction costs. The traditional method of collecting and analyzing data and using the IBM Watson artificial intelligence system to make recommendations was compared. Accordingly, it was found that with the use of the traditional manual method, these processes took 20 minutes, while this time was reduced to a maximum of 12 minutes by physicians. With IBM Watson, it was concluded that all these procedures, including analysis and treatment recommendation, were performed in only 40 seconds (Yorgancıoğlu Tarcan et al., 2024:17).

The other important AI application developed by the Methodist Research Institute in Texas, USA, to calculate breast cancer risk. It can detect breast cancer risk by using mammography data of millions of patients. With this artificial intelligence application, researchers evaluated mammography and pathology reports of 500 patients. It was concluded that the AI application developed in this context can diagnose 30 times faster than a physician with an accuracy of 99% (https://www.wired.com/story/cancer-risk-ai-mammograms, Access:30.11.2024).

China is the country with the highest government investment in AI and an application was used to determine when a comatose patient would wake up. It is applied on a 19-year-old patient and AI prediction determined when this patient would wake up and what procedures needed to be performed after waking up. In this way, it minimized transaction costs with timely and accurate resource utilization (https://www.scmp.com/news/china/science/article/2163298/doctors-said-coma-patients-would-never-wake-ai-said-they-would?module=perpetual_scroll_0&pgtype=article, access:30.112024).

The radiology unit of Mater Hospital in Dublin/Ireland solved the problem of the patient and the hospital in terms of time, process and costing with the application of AI. In this context, a digital twin of the hospital was created. In line with the suggestions given to the hospital by the Digital Twin AI, a 13-minute reduction in the waiting time of patients for Computed Tomography and a 25-minute reduction in the waiting time for MRI (Magnetic Resonance Imaging) was achieved. This also resulted in 50 minutes of overtime costs per day and an annual savings of 9500 Euros. 22.. Similarly, in the US, it was concluded that the application of artificial intelligence for diagnosis and treatment could save approximately 150 billion dollars in healthcare services by 2026. Within the framework of these applications, it was found that 40 billion dollars could be saved with robotic surgery applications, 20 billion dollars with virtual nursing applications, 16 billion dollars with the correct dose of medication to be given to patients and 3 billion dollars with radiology images (https://pmc.ncbi.nlm.nih.gov/articles/PMC10500367/, access:30.11.2024).

In addition to the advantages provided by the mentioned application examples, there are also opinions that the use of artificial intelligence in the field of health may not always yield the results as predicted. For example, the

success of artificial intelligence in radiology has been frequently mentioned in studies. Google executive Geoffrey Hinton, one of the creators of modern deep learning methods and winner of the Turing award, gave the following advice in 2016: "Deep learning algorithms will do this better than radiologists in the next five years". However, nothing even remotely close to this has happened yet, and the demand for radiologists has increased. This is because radiological diagnosis is beyond machine capabilities, requiring more situational and social intelligence than, say, customer service. New research shows that when human expertise is combined with new technologies, much more effective results are achieved. Algorithm and human cooperation provides effective results, especially in identifying challenging cases (Acemoğlu-Johnson, 2023:295). At this point, it can be stated that in order to get the most effective results with the use of artificial intelligence in health, artificial intelligence should be used not as a leading role, but as a complementary and supportive tool for human power. It should be emphasized that artificial intelligence can never replace human beings in a process where human intuition is at the forefront.

However, with the widespread use of AI tools in the health sector, huge amounts of data from different channels must be analyzed and processed correctly to ensure maximum efficiency. At this point, it is necessary to mention the importance of big data analytics.

THE IMPORTANCE OF "BIG DATA" ANALYTICS IN THE HEALTH SYSTEM

One of today's most strategic digital tools is data. Big data are large or complex data sets for which conventional data storage, processing and analysis practices are inadequate. Big data is obtained through five main sources. These are remote sensing, in situ sensing, simulation, social media and digital infrastructure data (Li, et al., 2019:329).

Big data, which is the basic raw material of artificial intelligence, is an application with significant impact in the health sector as in all areas of life. The use of big data in the provision of health services will bring significant advantages in increasing service quality by providing important functionality in effectiveness and efficiency. Big data is a public good that has the potential to make a significant contribution to the quality of provision of general and local health goods and services due to the direct raw material of AI (Maciejewski, 2017:124-128).

Data sources driven by AI, mobile devices, and the Internet of Things are more complex than traditional data. Many of the different types of data from sensors, devices, video/audio, networks, log files, transactional applications, web and social media sources are generated in real time and at a massive scale. In this context, more advanced analytical techniques than traditional databases must be used to process data (IBM, 2023).

Big data, which comes into play at this point, is larger, more complex data sets, especially more complex than new data sources, which enables data of a size that traditional data processing software cannot manage to be processed in high volume, high speed and high diversity. In essence, big data refers to huge amounts of information that are analyzed by certain technologies and created by digitizing each information. In this regard, all sectors are changing the way they manage, analyze and benefit from the billions of data they have. One of the most notable areas where data analytics is making major changes is healthcare. Created by the adoption of digital technologies in healthcare that collect patient records and help manage hospitals, big data analytics used to identify large volumes of information that are too large and complex for traditional technologies have many positive and life-saving consequences. While the number of sources from which healthcare professionals can obtain insight from their patients is increasing, the fact that this data comes in different formats and sizes than normal challenges the user. The most important issue at this point is that the data should be managed just as smartly as the data is "big". In this context, data analytics uses the obtained data smartly and quickly from sources such as patient portals, electronic health records, research studies, wearable techs, search engines, general databases, government institutions, payment records, personnel programs, to create detailed reports and use them to provide better service.

Some examples of how processes in healthcare can be improved in line with this approach can be listed as follows: (Batko and Slezak, 2022; Coursera, 2023; Cozzoli et al, 2022; Srinivasan, 2020; Liao, 2022)

a) *Determining the Number of Personnel*: Accurate measurement of the number of personnel is one of the most important elements to prevent waste of resources in the provision of health services. If too many staff are employed, one will face the risk of increaseed unnecessary expenses, and with too few employees, one will face poor customer service which could be fatal for patients. How many people are needed to be recruited or laid off in any given period should be determined through big data analysis.

b) *Improving the predictive analytics, interoperability and traceability capability*: This ability is important to explore data and identify useful correlations, patterns and trends, and extrapolate them to predict what is likely to occur in the future. Also Interoperability capability has been developed and is used to integrate data and processes to support management, collaboration, and sharing across different healthcare departments,

managers, and facilities. Traceability capability has been improved and this ability is useful to integrate and track all patient history data from different IT facilities and different healthcare units.

c) *Control of Electronic Health Records*: It is the most common implementation of big data in medicine. The person's demographic information, medical history, allergies, laboratory test results, etc. digital records containing information are shared through secure information systems and are available to both public and private providers. Because each record consists of a modifiable file, updates overtime can be implemented without any paperwork or danger of data duplication.

Correct management of recorded data has great importance in order for the examples mentioned to gain functionality and increase efficiency in the system. In the many healthcare system, data collected through e-health applications are recorded in the Oracle data warehouse. Within the scope of Oracle data warehouse, data must be prepared very carefully before being reported. This application does not tend to retrieve data very quickly and prepare it instantly when accessed (Oracle, 2023). At this point, it can be said that there is a need for faster anonymization and management of information in order to develop big data analytics in the healthcare system and improve processes in healthcare services.

On the other hand, within the scope of the examples in question, it can be said that the gains to be achieved with big data analytics depend on the effective use of artificial intelligence implementations individually. Individuals' personal activities to improve their health status and their participation in the system will enable much more progress in data analytics. At this point, applications where each individual can manage their own health information come to the fore. These applications have potential risks, and at this point, transparency and reliability are much more important. For example, in 2016, Google (Google DeepMind) made a secret agreement with the Royal NHS Trust, which holds the confidential information of 1.6 million British patients. According to the agreement, GoogleDeepMind will be able to have all kinds of sensitive personal data without the knowledge and consent of patients (Kurtoğlu, 2019:203). With this development, which is a very important risk factor in terms of human health and privacy and national health policies, technology companies have become the sole decision-makers in terms of the world health system. In this context, storing personal health records within the scope of secure applications has great importance.

Storing personal health records more reliably and providing transparent access to information is possible thanks to blockchain-based applications. In this regard, it should be evaluated what problems can be prevented and what advantages will be gained by replacing existing health applications with blockchain-based applications.

BLOCKCHAIN BASED APPLICATION IN THE HEALTHCARE SECTOR

Healthcare data is the most valuable source of healthcare intelligence. Sharing healthcare data is an important step to make the healthcare system smarter and improve the quality of healthcare. Controlling the patient's health data, which is one of the patient's personal assets, instead of distributing it to different healthcare systems, may put data sharing and patient privacy at risk. In contrast, blockchain-based applications show that reliable, auditable computing in the healthcare sector, as well as in the financial field, is possible using a decentralized network accompanied by a public ledger (Yue, Wang, Jin, Li and Jang 2016: 218). In this context, the features of blockchain, especially reliability and transparency, and the advantages it will provide in the healthcare sector should be evaluated in detail.

Definition of Blockchain

Blockchain technology, which is a transparent and verifiable technology designed for the safe and secure storage of data containing value, the exchange and management of data between two parties without the need for an intermediary. Blockcahin is known best for its cryptocurrency named "Bitcoin", which was released in 2008 by a person or group named Satoshi Nakamoto and which blockchain technology was first used for in order to solve Bitcoin's double-spending problem, but soon began to be used in many other applications. This technology, which is called "blockchain", meaning chain-connected blocks, because a block is connected to the previous and next blocks with a hash algorithm, is mostly used for applications in crypto currencies and the financial sector. Bitcoin is the most fundamental implementation area where blockchain technology works. The distinction that needs to be made at this point is that blockchain is a basic technology application with broader features than Bitcoin. The basic features of blockchain, decentralization, permanence, transparency and anonymization, distinguish it from other systems. In this context, it is defined as a ledger that constantly grows by storing transactions on interconnected blocks, enables entities to interact without a central third party, and allows information to be distributed by recording data entries in a decentralized manner. Thanks to its decentralization feature, the content added to the blockchain cannot be controlled by any central authority (Nakamato, 2008). This distributed and decentralized

feature, integrated with certain hashing and encryption mechanisms, provides higher security than centralized designs. In addition, some analysts claim that it is much more difficult for a malicious and unsuitable actor to access and modify data on the blockchain by removing traces of this breach, compared to existing central infrastructures. However, unlike centralized systems, it is stated that the functions of the blockchain continue even if certain nodes fail. Thanks to the persistence feature, it becomes impossible to delete entries stored in more than one node after they are accepted into the blockchain. In this technology, each participant keeps a copy of all records from the beginning. Since changing these records will cause the summaries to change, most people can notice this when the records are changed. Therefore, the need for a central database in a reliable environment disappears. With a distributed database system that anyone can verify and eliminates intermediaries (or keeps them reliable), it can be proven that accurate information is stored transparently without the need for mutual trust (TÜBİTAK, 2022).

Recommendations for the Use of Blockchain in the Field of Health

With the use of artificial intelligence technologies and big data analytics, access to all kinds of information in health services has become easier. However, as access to information has increased, concerns about privacy have also increased. At this point, it is thought that thanks to the use of blockchain technologies, many problems and concerns will be eliminated in healthcare services.

Interest in the use of blockchain in healthcare services is increasing day by day, and development studies are being carried out in this field. In the blockchain, which enables the creation of a lifelong protected record of a person's health data, information about when everything related to these records was collected and by which entity is processed. This system is different from the current systems where health-related data is stored and exchanged through multiple different devices and clouds within various public and private actors that require different authentication methods. It is a much more suitable option in terms of the privacy of patient data in the healthcare sector.

Some areas in the current functioning of the healthcare industry are quite suitable for technological transformation through the blockchain protocol and have great potential. Blockchain applications in the field of healthcare enable many transactions to be carried out in many areas, from electronic health records to the pharmaceutical industry, from clinical research to health insurance, from medical equipment supply to medical education. The first trials of this technology in the field of healthcare were on electronic health records, which were transferred in a transparent and reliable manner. The world's first examples of blockchain use in healthcare services are MedRec, MedChain, MyPCR, FHIRCain, HealthChain, MediBchain, ModelChain, BlockchainHealth, eHealthWallet and Medvault. These are some of the platforms where patients can access their own health information and personal health data are made available to the service provider (Aydar&Çetin, 2020: 533-540). With these blockchain-based applications, the first steps of a new era are being taken in the healthcare industry.

Health records are most private information for any person. By using this technology, where health information is stored, to monitor patients whose treatment continues outside the hospital and who need to be under surveillance, it becomes easier to monitor processes such as average recovery time. In this way, while efficiency in resource use is ensured, security in accessing personal records is also guaranteed.

There are academic and proof-of-concept studies in this field. eHealth, Healthchain, MediBchain, ModelChain, BlockchainHealth, eHealthWallet and MedVault some examples that can be given for this project. Thanks to these applications, people's health data are recorded based on confidentiality and unchangeable history (Aydar&Çetin, 2020: 533).

In addition to the advantages provided to individuals and service providers in health information systems, the use of blockchain is of great importance in ensuring integrity in health research. Easy and fast access to health data enables more and better research. The use of technological applications in the field of health develops depending on academic studies. Although there is a funding shortage in this regard, these studies should be supported as much as possible in order to pave the way for scientific studies. At this point, it can be said that with the use of blockchain, unchangeable and verifiable records can be used by researchers as a distributed data center, and integrity is ensured in scientific research by providing access to information with predetermined aspects.

Using blockchain at this point saves both time and cost for companies operating in healthcare market. Health Bank is an example of using blokchain in health records. It is a global digital health initiative based in Switzerland. At its core is the concept that patients can store their health data on the blockchain network and share this data with health researchers within their control. The company aims to increase transparency in the use of patient records in healthcare research by using the blockchain protocol (Dalianis et al., 2015: 15).

In addition to the personal health record applications mentioned, the following suggestions for the use of blockchain in the field of health should be taken into consideration:

a) *Drug Development and Pharmaceuticals Supply Chain*: The process from development of a drug to commercialization is very long. In the healthcare industry, transparency is needed at points such as clinical trials, supply chain control, product verification and quality control before products are commercialized. German-based Pfizer, Amgen and Sanofi, one of the world's largest pharmaceutical companies, are working collaboratively to find the most effective ways to apply blockchain technology to store secure data, accelerate clinical trials and reduce drug development costs. A report published by BioMed Central notes that reproducibility of studies in a clinical trial has long been an issue, and that implementing blockchain can integrate privacy with secure, decentralized tracking of all data (BMC Medicine, 2023). The problem of counterfeit medicine, which is seen at very high rates especially in underdeveloped and developing countries, is one of the most important problems in the health sector. Assuring patient safety is the most critical and priority issue for the healthcare industry. Therefore, the accuracy, integrity, traceability and safety of medicines from the production stage to consumption are very important.

b) *Improvement of the registration and billing process of clinical transactions*: Many hospitals providing healthcare services suffer financial losses due to billing errors. Especially in health systems that are reimbursement institutions, hospitals may face high penalties due to billing errors. In this case, both the institution's reputation is damaged, and the devastating effects of financial damage are difficult. At this point, it is claimed that these problems can be overcome with the use of blockchain technology. Blockchain technology has not only reduced management costs in information reporting and payment systems through smart contracts, but also saved time. A blockchain-based medical information sharing system uses keyword searchable encryption to ensure data privacy and security. In this way, each payment is examined individually, reducing the burden on insurance auditors. Data collected on the network is securely stored in a decentralized manner on the blockchain layer. Applications are executed in the application layer by receiving data from the blockchain layer (Sivasankari&Varalakshmi, 2022: 277).

c) *Ensuring transparency in insurance is included*: One of the most important factors that increase costs in private health insurance is the asymmetric information problem. The person who wants to get health insurance has more information about his health condition than the insurer. It will be possible to prevent the asymmetric information problem that occurs at this point with the use of blockchain technology. If a blockchain network is to be established in the insurance industry that will enable the display of patients' health histories, patients must give explicit consent to the processing of their health data in order to participate in the system (Blockchain Turkey, 2019: 67). It can be said that in order for the use of blockchain to create a transparent environment in the system, that encourage the patient with data to give explicit consent can be implemented.

d) *Preventing disruptions during the pandemic process and other crisis times*: The pandemic has accelerated the digitalization process in every field, and it is necessary to understand the necessity of digital applications in the field of health. At this point, there is a need for a platform where data fraud can be prevented in times of crisis, a safe environment can be provided for records that need to be protected with precision in the healthcare sector, and physicians can be sure that the information about the covid-19 virus and infected patients is shared with permission and by reliable healthcare personnel and is not changed (Barry and Heisle, 2020: 4). This needed platform is possible with blockchain-based identity systems.

In addition, during the pandemic process, the necessity of digital applications has once again come to the fore in matters such as tracking donations, insurance claims, tracking the medical equipment and pharmaceutical supply chain, tracking data related to the epidemic, and tracking international payments. Thanks to the transparent and open information sources offered through Blockchain, all these issues are tracked accurately. With blockchain-based health information systems, identities are assigned to healthcare workers using asymmetric keys, and employees can sign the data they want to share with their private keys, create a verifiable reference of the data, and share it on the platform (Sporny et al., 2019). It is possible to confirm the originality and unaltered data with the help of the public key of the person sharing the data. Mipasa can be given as an example of this application. This blockchain-based project allows individuals, government institutions and healthcare organizations to share data with each other while protecting their privacy, with the aim of early diagnosis of COVID-19 carriers. Using Hyperledger Fabric blockchain technology, MiPasa can run artificial intelligence algorithms to analyze confirmed data. MiPasa is supported by a consortium of organizations including IBM, Microsoft, the World Health Organization, John Hopkins University and the National Health Commission of China (Mipasa, 2020).

CONCLUSION AND SUGGESTIONS

Digitalization increases quality and efficiency in many areas such as economy, education, science and health. Thanks to digitalization in the field of health, minimizing human errors and increasing service quality, accelerating access to accurate information in decision support processes and ensuring integrity in health research increase people's access to health services and the efficiency of services. In this context, especially in recent years, studies on the digital integration of health systems have been gaining momentum in order to increase the health status of people around the world.

Digitalization initiatives aimed at providing healthcare services quickly, effectively, efficiently and economically enable the use of various information systems in the management of this field, and it is observed that these initiatives increase proportionally every day. Since it is accepted that the use of technology in health services increases health expenditures in different approaches, decision makers may have a more hesitant attitude towards the digital transformation of health systems. However, within the scope of the applications mentioned in this study, it can be said that especially electronic health records provide significant savings in terms of both time and cost. In the digitalization process in the field of health, keeping health statistics and facilitating access to information makes it possible to detect diseases that cause an increase in health expenditures, plan services within this framework and reduce costs. In addition, people's individual participation in healthcare services through digital applications reduces costs as it prevents diseases before they occur.

Today, digital applications such as telemedicine, mobile medicine and e-health are widely used in the provision of preventive health services (healthy nutrition, preventive health, physical activity, etc.), treatment of various chronic diseases, physical and mental health problems through distance treatment. In addition, the use of digital technologies has benefits such as providing citizens with more accurate information about their health status, sharing experiences with people in a similar process, monitoring and evaluating certain health conditions and behaviors, evaluating medications, selecting the appropriate treatment method, and improving communication between the patient and the health worker (Demirci, 2018:716). In this context, it can be said that digitalization ensures the effectiveness in every field of healthcare and decision makers should update their health systems accordingly.

Today, one of the most important points that decision makers should pay attention to in the digitalization process in healthcare services is the protection of personal data. The digitalization process in the healthcare sector brings some drawbacks along with all the gains aimed at reducing costs, minimizing human errors and increasing efficiency in the healthcare system. The most important of these is the seizure of personal health records for misuse. Applications with high reliability in terms of data protection are blockchain-based applications. While integrating the health sector into the digital plane, governments prioritize national technologies, taking into account the privacy of citizens regarding their health data. These technologies should be supported by blockchain-based applications within the scope of their features such as being reliable, transparent, decentralized and unchangeable.

Nevertheless, it should be kept in mind that the margin of error in the use of digital technologies is not zero. There are opinions that artificial intelligence cannot replace human intuition in diagnosing diseases and may make mistakes when it encounters different symptoms because it cannot go out of routine. For example, in 2018, an application used in more than half of the US states was used to determine how much healthcare people received. However, when this algorithm was implemented in Arkansas, there was a software bug that incorrectly and unexpectedly terminated the healthcare received by people with cerebral palsy. For example, a patient with cerebral palsy who needed help with everyday functions, such as getting out of bed, suddenly had her care time reduced to 24 hours per week. The lawsuit revealed that artificial intelligence applications negatively affect people with diabetes and cerebral palsy. Such algorithmic errors psychologically cause patients to live with the fear that medical assistance will be suddenly cut off (Thomas, 2024:112-113).

We are still in the early days of the widespread use of artificial intelligence in the medical field. However, the number of surgeries performed by physicians with the support of artificial intelligence independent of space is increasing. Especially robots are used in certain surgeries as auxiliary-complementary elements to surgeons. In this way, artificial intelligence applications provide significant benefits to the physician and the patient as measures to reduce time, transportation and other operational costs. Therefore, the main subject in an AI-enabled healthcare system is patients. Patients' experiences, trust and satisfaction with AI-supported medical applications are of great importance.

In medicine, domain expertise is far more important than any applied machine learning project. For example, radiologists working in deep learning have found mislabeled chest X-ray datasets that those without any medical background cannot recognize. Medical domain expertise does not only encompass the knowledge and experience of doctors. While the knowledge and experience of doctors is important, patients also have different levels of

knowledge, skills and expertise about their disease. Patients are important actors in making the pain and other symptoms they experience meaningful and understandable for physicians in the treatment process. Treatment is not a one-way process. On the other hand, the data obtained in diagnosis and treatment will influence the vital decisions that AI will make in the future. Therefore, although artificial intelligence provides great advantages in medicine, patients should be put at the center and their knowledge and experiences should be listened to carefully. "Data is not bricks to be stacked, oil to be drilled, gold to be mined, opportunities to be obtained. The data obtained in medicine are people to be seen, perhaps loved and cared for". Unlike other fields, health services, unlike other fields, need to be regulated in a human-centered manner in order not to be worn out too much by the artificial intelligence revolution (Thomas, 2024:114-116). At this point, the human needs and emotional needs of individuals that can only be met by a human being should not be ignored during the disease treatment process. Digital technologies should only be used to minimize physician errors in medicine and to provide support to healthcare personnel when manpower or analytical thinking is insufficient. According to the examined application examples are evaluated, although transferring the leading role to digital applications in the field of health information processing is the right step in terms of cost and error minimization, digital technologies in the medical field should only be integrated into the system as a tool to support human beings.

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