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Chapter *in* Studies in Computational Intelligence · January 2022

DOI: 10.1007/978-981-19-2416-3_16

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Digital Transformation in Healthcare Industry: A Survey

Harpreet Kaur Channi, Prateek Shrivastava, and Chiranji Lal Chowdhary

Abstract In the current environment, it can be seen that the healthcare business is completely reliant on digitalization via the use of different new technologies that make it simpler to operate and the system more sustainable. For several decades, the use of Internet of things (IoT) and information and computer technologies (ICT) has made work simpler in the healthcare business. Enhancing admiration and providing new insights into drugs and treatments in healthcare technology, or improving the overall quality of care offered. All of this is only possible because of cutting-edge technology. The numerous demonstrations of rising trends and technologies employed in the healthcare business in this article have been addressed. In any industry, digital transformation is the most difficult task and the most difficult implementation, but when the importance of big data in healthcare is considered, recent market trends in healthcare devices, growth, and predictive healthcare, all of these things are possible thanks to the wonder of IoT. The necessity for IoT and several technologies that are quite useful in healthcare is considered in this chapter. Because of the rapidly increasing death rate, the latest pandemic of COVID-19 disease necessitated data analysis that is very complicated and typical to getting out results, but some researchers and medical institutes found a solution to that problem and as expected, digitalization in healthcare makes it possible to control the situation. Various healthcare equipment, such as smartwatches, oximeters, and glucometers, continuously monitor our health and provide input to the body for specific needs and updates.

Keywords Healthcare · E care · Digital transformation · Monitoring · Telemedicine · IoT

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B. K. Tripathy et al. (eds.), *Next Generation Healthcare Informatics*,
Studies in Computational Intelligence 1039,
https://doi.org/10.1007/978-981-19-2416-3_16

1 Introduction

Healthcare is the fastest expanding business, and telemedicine and virtual treatment of patients save both time and money. The healthcare industry in India is fully digitalized, embracing artificial intelligence (AI) and machine learning, and different modern technologies are assisting in a huge transition. In India, the healthcare market is continually concentrating on new and sustainable healthcare technology to better people's lives [1]. In healthcare distribution, a shortage of skilled healthcare practitioners and related infrastructure gaps never meet demand, but advances in digital equipment and education make it feasible for sustainable healthcare. India has a population of over a billion people, and all of them are linked via smartphones, which have numerous capabilities such as health monitoring and body condition, which is a new development in digitalization [1]. However, following the COVID-19 epidemic, the government has made certain initiatives in the areas of medication prediction mistakes, decreased time and expense in hospitality, identifying high-risk patients, and the extensive use of computerized healthcare. In the modernization of the healthcare business, an electronic health chart is a person's health record in digital form that is safe and instantly available for authenticated persons, allowing us to conveniently care for that individual through a digital link.

1.1 Healthcare with AI and ML

The healthcare business is continually working on new technologies and trends to enhance the overall quality of treatment or health. Medical algorithms were utilized to create corrective action plans that took into account diagnostics and X-ray findings, as well as different data resources from the data storage center, and displayed them in a logical order [2, 3]. Every aspect of the healthcare experience is enhanced by the use of technology. From exposing doctors to new equipment to using telecommunications to link patients and caregivers hundreds of miles apart, technology and medicine have developed throughout the decades. Patients are attending video conferences with physicians as part of today's rising trends in healthcare, saving time and money that would otherwise be spent commuting to another place. The Internet of things (IoT) introduces a slew of new integration tools. Using the power of linkages and data to connect payers, pharmaceutical companies and providers to patients may have a significant revolutionary impact. Smartwatches, fitness trackers, pacemakers, and other sensor-based devices, such as current mobile phones, are accelerating the use of IoT in healthcare [4, 5]. Companies like Forums Health, Heart Design Labs, and Bango are successfully implementing IoT in areas like remote retina imaging, heart tracking, and blood bag monitoring. As the 5G deployment progresses and gadgets become more affordable, this market will grow even more.

2 Healthcare Industry Application Programming Interface

Healthcare organizations are collecting massive amounts of data and putting it to greater use by combining massive amounts of data, machine learning, and industrial IoT technology [6]. Expanded data gathering and analysis have a number of advantages, including better management and therapy, disease prevention, and individualization of healthcare. Here are a few examples of hospitals using technology to better data analysis:

- Cloud—Data sharing, quicker search and retrieval, and interoperability across healthcare systems, IoT devices, and apps are all made possible by these technologies.
- Artificial intelligence (AI)—It may be used to diagnose medical pictures and EHR data, as well as analyze massive datasets to produce patterns and forecasts, and can therefore replace human professionals in various sectors.
- Big data analytics may be used to track public health records, social media sites, and other information sources for information that might be beneficial to medical institutions, such as sickness outbreak reports, complaints, and healthcare evaluations.

If medical treatment is to be digitized, data sharing must be safe and efficient. APIs must enable proper data sharing with both electronic health records, medical equipment, and other integration. This might lead to more accurate and prompter diagnosis and treatment in the long term. Security must be considered when developing APIs. Businesses that invest in safe, compliant system integration will be better poised to supply new digital services [7, 8]. An API is a communication interface that allows software developers from different companies to speak with one other. They serve as a link between two programs, enabling data to flow regardless of how each program was created. An API is especially important for applications that pull a constant stream of data from one or more sources in order to reduce development time, save storage space on endpoint devices, and overcome any differences in the standards or programming languages used to create the data on either end of the bridge as shown in Fig. 1. Because Expedia and Kayak do not develop their own data, they are unable to give flight price comparisons from ten or twelve different airlines [9, 10]. They just connect to each airline's flight scheduling software using the API given by each airline and pull information into a single view for the end-user.

2.1 Importance of APIs in the Development of Human Health

Compatibility is done by creating points of interaction across systems, which will deliver more relevant data to healthcare professionals and users [11–13]. Patients' health records must be available, accessible, and intelligible as they move through

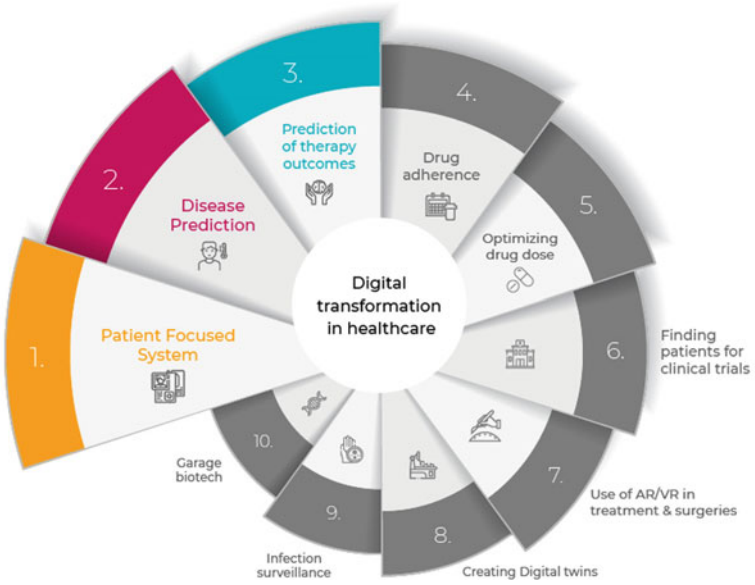

Fig. 1 Digital transformation in healthcare

the healthcare ecosystem. There are three technical criteria for the API that must be met.

- *Security:* A mechanism for establishing a connection with the application that requests classified material must be included in the API. There have to provide a means for apps to authenticate with the data source, be allowed to receive access, and keep track of any interaction with the source of data.
- *Patient selection:* To conduct data queries for a patient's record, the API would need to allow applications to inquire for the patient's medical record's ID or another identifier.
- *Data requests, response scope, and return format:* The API would handle queries and replies "by data category" and "all." While the data stated in the standard medical dataset is required for certification in both cases, extra data is permitted and encouraged.

These laws encourage developers to create APIs that are tailored to their institution's needs while clarifying security and data integration standards [14, 15]. To maintain safe connections identification, permission, encrypting, and authentication are frequently used in well-managed healthcare API transactions.

Authentication credentials, which typically utilize login information, are used to validate a user's identity and what resources they have access to. To improve security, Internet security certificates and equipment keys can be employed [15, 16]. As shown in Fig. 2, encryption safeguards healthcare information from unauthorized access and

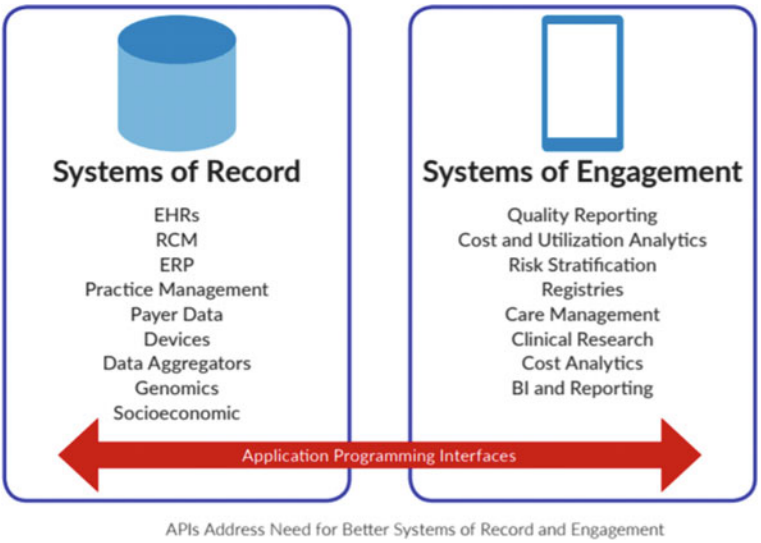

Fig. 2 Application programming interface

functions as a safeguard in the event that it is stolen. Identities are frequently used to authenticate API calls and guarantee that data in transit has not been tampered with.

3 Challenges in Digital Transformation of Healthcare

Digital transformation in hospitals has immense potential, but it also faces significant challenges. The following are some of the key roadblocks to the healthcare sector's modernization.

- *Information Governance:* In the healthcare industry, data processing and analysis are key difficulty. Part of the difficulty is the massive quantity of data collected by hospitals, clinics, and healthcare providers [17]. Without an AI system capable of digesting this data, organizations would be unable to provide better-personalized therapy. Another significant problem is data collecting and synchronization. Medical workers operating from various locations on different systems find it challenging to update patient health data using telemedicine. All data applications and procedures for data storage are depicted in the diagram below (see Fig. 3). There has to be a means to capture and health records should be updated from numerous devices for both face-to-face and virtual encounters.

- *Cybersecurity:* One of the most essential challenges for healthcare businesses is addressing the danger of cyberattacks. Healthcare is one of the top businesses targeted by hackers, according to several security research reports. Because of

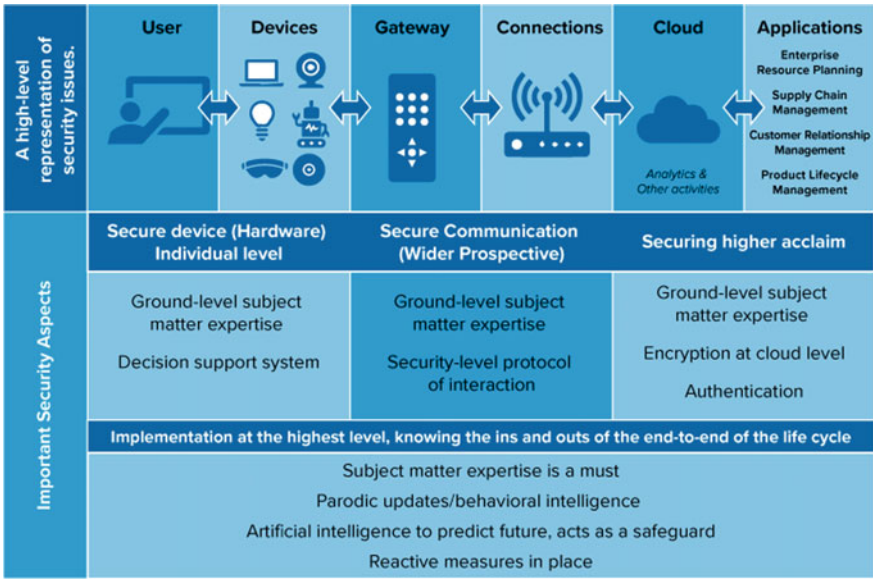

Fig. 3 Procedure for data storage

the enormous number of IoMT-connected devices, the volume and availability of medical and patient data, and the complexity of patient care delivery models, risks are increasing. The healthcare security perimeter has a considerably bigger attack surface, encompassing many enterprises, IoMT devices, cloud systems, and traditional medical equipment. Furthermore, despite greater security monitoring and investment, many businesses' security measures are inadequate [18]. Thousands of medical gadgets are kept in most hospitals that lack adequate security measures. While firms are dedicated to digital transformation, risk management approaches are not always up to date**.**

- *Data Security:* The risk of revealing patient data rises considerably when the healthcare industry shifts to collaborative healthcare. Collaborative medicine is a delivery model that makes patient data available across complex medical contexts, allowing it to be accessed by a large number of users on a variety of devices and in a variety of locations [19]. Data may also be accessed by medical practitioners and biological researchers in order to enhance appropriate medical and patient care, such as through the use of AI technology for healthcare monitoring and diagnosis. Without adequate data privacy controls in place, the risk of sensitive data loss and compromised clinical management would increase (Fig. 4).

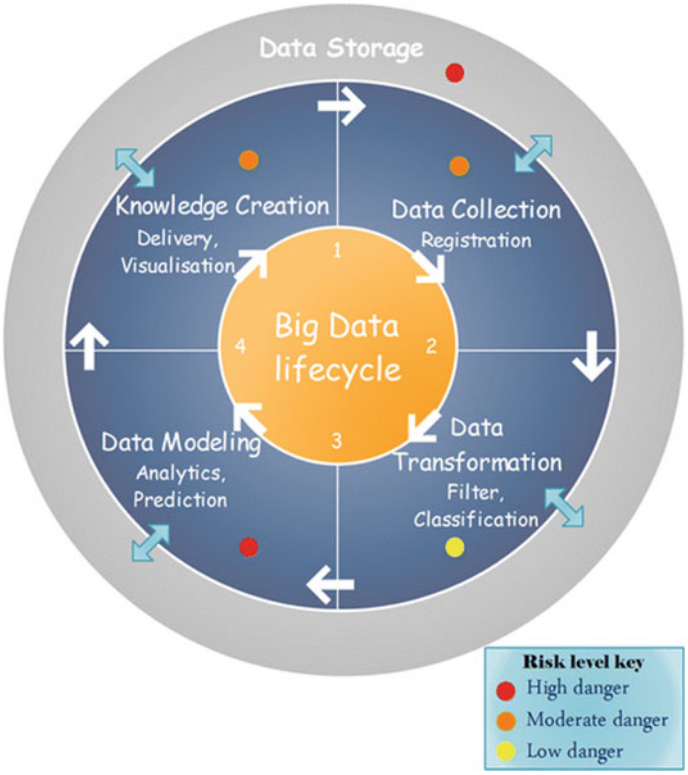

Fig. 4 Big data lifecycle

4 Future of Healthcare Technology

The future of healthcare is a system that seamlessly integrates data on a patient's medical history, real-time health, healthcare coverage, and financial data to improve expert judgment, enhancing treatment health, and save money as shown in Fig. 5. As per the CISO, one technological breakthrough that is already beneficial is the speedy transfer of patient data, which enables physicians to better understand the context of a patient's entire health. "Providers must continue to transition away from manual data exchange approaches such as faxing information to one another and toward automation." Improving EHR data integration implies that labs, treatment plans, and medical histories from several sources may be accessed in minutes or seconds rather than days or weeks, allowing the physician to develop a clear diagnosis and build the most effective care plan in less time [20, 21]. Regardless of whether new technology emerges that improves health and reduces costs, patient privacy must remain a key consideration for technologists and clinicians. Selecting the correct data management partner will become even more important in future.

Fig. 5 Future of healthcare technology

4.1 Technology Trends in Healthcare

Artificial intelligence (AI) can help cut costs by automating time-consuming tasks that people used to undertake, allowing healthcare workers to focus on more sophisticated or patient-centered work [22, 23]. When suitable, AI may also be used to allow patients to use self-service terminals, allowing clinics or hospitals to deploy resources in the most efficient way possible for patients' health. Officials in the healthcare business are frequently forced to choose between the price, accessibility, and efficacy of their services. Medical treatment would be entirely accessible, inexpensive, and effective in an ideal society. In reality, however, this is not the case (Fig. 6).

Customizing Care: Unlocking the future when the COVID-19 pandemic broke out in early 2020, healthcare practitioners stepped up their efforts. Despite statewide shutdowns, social distancing measures, PPE shortages, and other challenges, healthcare practitioners looked for solutions to delayed patient treatment while managing massive influxes of COVID-19 patients. Healthcare has experienced a decade-long change in an instant, from telehealth to remote patient monitoring, online patient portals to drive-through clinics. Because of the outbreak, healthcare innovation was vital [24]. Healthcare companies are now moving swiftly to convert promise into reality. As per BDO's 2021 healthcare digital transformation survey, 93% of healthcare organizations have or are in the process of building a digital transformation strategy. For healthcare organizations, this entails redefining their approach to patient care, business strategy, and organizational processes via the use of technology such

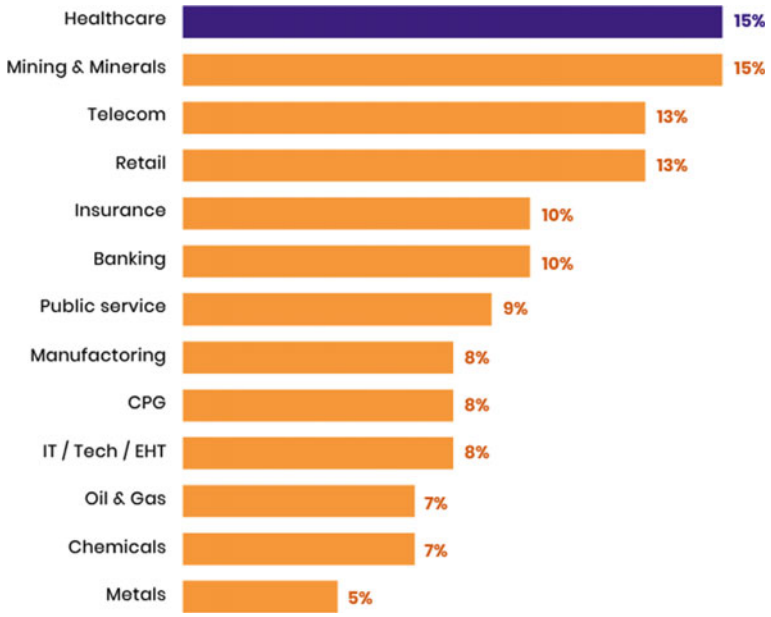

Fig. 6 Comparison of industry of AI

as telemedicine, predictive analytics, and artificial intelligence (AI). It is critical for healthcare providers to not just accept technology, but also comprehend how to use it to advance their bigger aims, bringing to reality services and capacities previously only envisaged in science fiction. A truly omnichannel patient experience, transnational patient safety, and automated revenue cycles are just a few of the healthcare possibilities [25]. These are not just pipe dreams for massive healthcare systems; new technology is now available and essential for all healthcare businesses.

The Indian market has long been in desperate need of innovative, sustainable, and scalable healthcare technologies to improve people's lives, which is exacerbated by the government's low allocation of funds due to vast inequalities in healthcare distribution, a lack of trained healthcare professionals, and related infrastructure gaps [26]. Despite the fact that India has a population of over a billion people, the great majority of whom own a smartphone, digital healthcare technology had little influence until this year, when numbers soared due to COVID-induced consumer and behavioral trends as shown in Fig. 7. This trend toward technologically enhanced healthcare, along with increasing government funding, improved access to healthcare information, and a better awareness of preventative health behaviors, all point to a changing industry.

Before we examine how digital transformation may affect healthcare in India, let us look at some of the sector's most serious concerns. Affordability is a major factor for people as they seek low-cost and low-cost alternatives. Another important difficulty is accessibility, which is exacerbated by the population's low ratio of

Fig. 7 Statistics of expenditure of government on healthcare year wise

healthcare providers. We will need 6.4 million more healthcare workers to fulfill global demands [27]. The problem is exacerbated by a lack of technical infrastructure, a lack of standards, privacy concerns, and gaps in the pharmaceutical, payer, and provider ecosystems, as well as a lack of comprehensive regulations. Looking ahead, the Indian market is well positioned to bridge the talent, location, infrastructure, access, and urban–rural expenditure imbalance. Preventative steps are being taken by the government, including the National Digital Health Mission, Ayushman Bharat, PM-JAY, and others. These government initiatives, which are fueled by the previous projects like the Digital India mission, Aadhar, and others, are laying the groundwork for India's healthcare digitization by providing a universal health ID and access to directories of physicians, practices, and digital health information for everyone.

5 Contribution of Digital Transformation

Telemedicine in India has gone a long way since its humble beginnings in 2001, when Indian Space Research Organization (ISRO) connected Apollo Hospital in Chennai with the Apollo Rural Hospital in Aragonda, Andhra Pradesh, as part of a pilot project [27]. It is gaining popularity as a growth engine, particularly in the aftermath of COVID. According to a McKinsey report, expanding telemedicine in India might save the country up to $5 billion every year. Changes in telemedicine practice guidelines allowed organizations such as proctor to declare a 500% increase in just a few months. Other developing players in this field include M-fine, my Upchar, Tattvan, Lybrate, and Docs App. Though yet in its infancy in India, blockchain technology has the potential to improve transparency, efficiency, and monitoring in the pharmaceutical value chain. It has the potential to significantly improve accountability and confidence in the healthcare sector as a whole. This was proven by a pilot undertaken by the government think tank NITI AYOG, which included business involvement. Entrepreneurs like Ethereum Health Wallet, PSI PHI Blockchain Labs, Prime Chain, and others are helping to grow this sector. AI/ML is a technology that is reshaping the healthcare sector. AI's use in healthcare is vast and varied, ranging from the discovery of novel drugs to the prediction of negative consequences, from supply chain forecasting to predicting the next best step for sales reps to prescribing optimal

treatment pathways [28]. New alternatives will emerge as a result of genetic and deep learning methodologies, as well as advanced options like quantum computing.

This industry is populated by large organizations such as Phillips, Siemens, Microsoft, and Amazon, as well as small startups like Doxper, Niramai, SigTuple, and others. Microsoft, for example, has partnered with Narayana Health, Forus Health, Apollo Hospitals, and SRL Diagnostics to handle a variety of use cases ranging from diabetic retinopathy to histopathology. Through COVID, AI implementation has been accelerated. AI usage surged by 45% in India, the greatest of any major country, according to a recent PwC research (AI: An opportunity in the middle of a crisis). The government is also boosting awareness and creating a collaborative environment for all sectors, including healthcare, through programs like the National AI Strategy and projects like Responsible AI for Social Empowerment (RAISE). As a critical enabler, robotics is gaining traction. Robots are becoming more widespread in a variety of applications, from precise surgery to contactless patient care. At Fortis Hospital, the Mitra robot was presented, which combines face and speech recognition technology to evaluate visitors for COVID symptoms such as cough, fever, and lethargy [29]. In Chennai, a "robotic nurse" was used to provide prescriptions and food to patients at Stanley Medical College Hospital. AR/VR has several applications in healthcare. Pain management, cognitive rehabilitation, and patient therapy can all benefit from it. Medical students' education might be made more fascinating and useful by using real-life simulations. It can also assist doctors with surgery, training, and overall patient care.

Companies like Loop Reality, Inception, Health Connect Digital, and Imaginate Labs are helping medical practitioners, drug companies, and hospitals all over the country use virtual reality (VR) and augmented reality (AR) technologies to aid in therapy, surgery, marketing, and spreading medical awareness. The Internet of things (IoT) enables a lot of integration. Using the power of links and data to connect payers, pharmaceutical firms and doctors with patients might have a huge impact. Smartwatches, fitness trackers, pacemakers, and other sensor-based gadgets, such as current cellphones, are accelerating the use of IoT in healthcare. Companies such as Forums Health, Heart Design Labs, and Bango have effectively implemented IoT in areas like as remote retina imaging, heart tracking, and blood bag monitoring [30]. This market will increase even more as 5G rollout progresses and products become more inexpensive. While these are some of the most important technology enablers, there are certain fundamental digital capabilities that complement the strength of these technologies, such as cloud, mobile, Internet, software, and so on. Healthcare will be heavily influenced by all of the data generated by IoT and EHR/EMR systems, as well as ideas like federated learning and edge computing, as well as the possibility of AI and robotics at scale.

Although the delayed adoption of these technologies, India has enormous potential for digital healthcare transformation due to greater technology penetration, a larger population, lower pricing, and more healthcare awareness [31, 32]. With growing government expenditure and favorable laws, a robust startup environment, the presence of significant health-tech firms' research and innovation, and the upcoming 5G launch, COVID has given these concepts even more wings.

6 Relevant Case Studies

6.1 Case Study of Africa

With the rising problem of illnesses, Africa's healthcare faces several obstacles. However, digital technologies are likely to solve the majority of Africa's healthcare concerns. In several African countries, drones are increasingly being utilized to transfer blood and medical supplies to rural and disadvantaged populations. Academics, on the other hand, are still catching up with empirical study on the influence of drones on healthcare. In Ghana and Rwanda, a study was done using a questionnaire to collect responses from 298 people who work in healthcare institutions and zipline drone operating centers. Partial least squares structural equation modeling was used to examine the data (PLS-SEM). The findings show that information quality, system quality, service quality, user happiness, and perceived financial cost are all important factors in deciding whether or not to deploy drones in healthcare. Drones have also had a significant influence on healthcare delivery. The most essential elements and conditions supporting drone deployment for healthcare delivery were also recognized as short drone delivery time, healthcare facilities in distant places, and late arrival of medicinal supplies. Governments in Africa should explore accelerating the adoption and deployment of medical drone technology to save lives in hard-to-reach locations. Future research should focus on the obstacles and limitations that medical drones face [33].

6.2 Case Study of Poland

Many nations have been obliged to take a range of restrictive measures to prevent the COVID-19 pandemic from spreading further, including the use of medical teleconsultations and different instruments in the field of inpatient telemedicine treatment. Digital technology provides patients a wide choice of treatment alternatives while also posing a number of organizational issues for medical organizations. As a result, the question of whether organizations is prepared to deploy current telemedicine techniques in the event of a COVID-19 pandemic emerges.

Operational capabilities are the total of valuable, precious, one-of-a-kind, and irreplaceable resources, as well as the capacity to employ them. The second component is technological capabilities, which decide whether or not novel technologies are adopted and used. In contrast to the frequently held belief that technology has a negative influence on operational capabilities, we propose the opposite notion. The verification reveals that operational capabilities have a major impact on technological capabilities. The study is done utilizing a questionnaire designed by the authors that cover organizational e-readiness for digital transformation. Four of the 32 elements reviewed are connected to operational capacities, while the remaining four are related to technological capabilities. Our findings show that (i) a basic set of four variables

can effectively measure the dimensions of OC, namely degree of agility, level of process integration, quality of resources, and quality of cooperation; (ii) a basic set of three variables can effectively measure the dimensions of TC, namely adoption and usage of technologies, customer interaction, and process automation; and (iii) empirical results show that OC is on a higher level than TC in a number of areas [34].

7 Conclusions and Scope for Future Studies

The applications of healthcare technology appear to be limitless. Healthcare technology is being incorporated in everything from administrative procedures to more thorough and precise diagnostics in order to increase business efficiency and make the patient experience as comfortable as possible. Emerging technology in healthcare, such as programs that help in recognizing potential health concerns and reviewing digital information from test results and issue lists, also contributes to the advantages that healthcare technology trends provide to medicine.

As new medical technology and the progression to value-based payment models continue to take shape, we must constantly educate ourselves with the newest healthcare technology trends in order to manage technology rather than the other way around. The future of healthcare is collaborating with health technology, and healthcare personnel must adopt evolving healthcare technology in order to remain relevant in the years ahead.

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