IMPACT OF DIGITALIZATION ON SHAPING CONSUMER-CENTERED SMART HEALTHCARE SYSTEM - A COMPREHENSIVE STUDY

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ABSTRACT

We are on the verge of the Fourth Industrial revolution, in which digitalization, data analytics, and insights play a critical role in our daily lives. The COVID-19 outbreak has created unprecedented uncertainty for many firms. Healthcare organizations across the care continuum were confronted with new difficulties, forcing them to learn swiftly, adapt, and reinvent the way they offer traditional care. As a result, the notion of cost-effective, anytime, and anyplace care has entered the mainstream, forever altering the rate at which we obtain healthcare. As a result, healthcare industries across the globe started to rethink their tactics to be ready for the future and this new breed of customer demand. With rapid technological evolution, this paper analyzes the trends and recent shifts in the healthcare industry and how it is trying to be more customer-responsive by using emerging technologies.

KEYWORDS

Smart Healthcare, Digitalization, EHR, CCH, eHealth, mHealth, Cyber risk, IMT

I. INTRODUCTION

The pandemic has created many challenges, but at the same time, it has also provided an opportunity for organizations to improve their performance, resulting in the development of new customer interaction models and novel techniques to meet consumer requirements. In this digital age, e-health analytics are crucial in encouraging and empowering medical staff to make better and faster data-driven decisions[1]. Traditionally, the healthcare system has not always been straightforward, but it can and should be. A consumer-centered health system assists individuals in caring for their health most conveniently from anywhere at any time, providing them with alternatives throughout the whole range of care: digital, virtual, or in-person [2]. In the aftermath of this COVID-19 pandemic, medical care is becoming more consumer-centric, wellness-oriented, accessible everywhere, and digitally connected [2].

Virtualization and web consultation will be prevalent in future healthcare offerings. To support this paradigm shift and the new delivery ecosystem in healthcare, novel business models appeared. Artificial intelligence (AI), the Internet of Things (IoT), and blockchain technologies have also been lauded as fascinating technologies during this pandemic [3]. They instilled great faith in the development of current healthcare services during and after the COVID-19 pandemic. Healthcare professionals believe that technology acceptance and implementation will continue to rise across the healthcare spectrum, from drug research to precision preventative care to workflow management. With the emergence of smart healthcare, a human-first approach to health connects a wide range of facts to generate a complete picture of each person's holistic

health. It enables individuals to concentrate on their health and lives rather than navigating a fragmented conventional system.

In this article, we will discuss precisely what consumer-centered healthcare is, why we are talking about this now and how emerging technologies are influencing the same, starting from e-Health to telehealth. In the end, we will draw our insights with suggestions and conclusions.

II. WHAT IS CONSUMER-CENTERED HEALTHCARE?

With climate, demographic and technological shifts, the modern world deals with several economic, social, and environmental concerns. Because of the aging population and the growth of chronic illnesses, the need for better healthcare is expanding and shifting its focus in this post-pandemic period. As a result, healthcare puts individuals at the core of healthcare systems to assist and satisfy complete consumer health demands when, when, and how we want them to be fulfilled. Customer-centered healthcare refers to a new healthcare system in which the consumer is at the center of the process and driving innovation.

Moreover, several decades have been the scene of a true technology revolution that has profoundly reorganized society and human processes via a fundamental business model change [3]. Technology has permeated every sector, including healthcare, mainly how we consult, buy drugs, maintain our electronic health records (EHR), handle medical claims, and purchase healthcare insurance products [4]. This transition is challenging to manage, yet it delivers more openness and data security, fostering strengths, wellness, and affordable healthcare [3]. Recent laws allowing providers to adopt electronic health information sharing make the healthcare business more exposed to hacking but simultaneously make healthcare services transparent and efficient for consumers. The consumer-centered healthcare (CCH) focuses on four key ideas to successfully engage and manage patients in their new digital environment to better serve the people and research their behavior for future medication or wellness recommendations. The basic concepts are (a) Patient Empowerment, (b) Patient Activation, (c) Self-Management, (d) Shared decision-making, and (e) Adherence and Compliance. All these key criteria are highlighted below in Table 1 with a detailed explanation [5].

Concept	Definition	Relation to smart healthcare
Patient Empowerment	Patients are held accountable for their decisions and the consequences of their choices in an empowerment-based approach [6].	Empowerment shares a mutual influence connection with the notion of involvement. It promotes the excellent experiences that patients have on their engagement journey.
Patient Activation	This tells about the level of knowledge, skills, and confidence in the patient managing their care [7].	It tells about different degrees of overlapping concerning engagement, activation, and institutional care between the provider and the patient.
Self-management	This is a treatment that combines biological, psychological, and social intervention techniques based on beliefs and expectations [8]	Engagement defines the exchange between patients, the healthcare system, the provider, and the third-party providers.

Shared decision-making		
	Providers and patients must be encouraged to seek and read information from other sources to discuss their subsequent encounters [9].	This needs more negating roles with care management and maintaining systematic context between broader and systematic contexts.
Adherence and Compliance	Adherence and compliances refer to patients' ability and behavior to follow treatment recommendations [10].	Adherence describes a more democratic version of the exchange process between patients and providers. Compliance refers to policies, terms, and individual care contexts concerning government rules and regulations.

Table 1. Key Concepts related to the active role of patients in consumer-centric smart healthcare

III. AI AND THE RISE OF TELEHEALTH

Artificial intelligence (AI) seeks to assist physicians in making patient diagnostic choices by analyzing and recognizing insights from multimodal patient data. Clinical decision-making (CDM) was initially characterized as a constant and dynamic process of gathering information and selecting between two or more possibilities to construct a clinical diagnosis, interventions, interactions, and assessments within a context. With AI, telehealth is increasing in popularity across platforms to aid patients with individual features study anywhere and at any time. According to Deloitte's latest 2021 forecasts, online medical visits will surpass 400 million worldwide next year [11].

Telehealth will continue to develop as the cornerstone of a solid healthcare plan appropriate for the new regular long after the pandemic has passed. Future healthcare trends will center on patient-centricity and consumer-driven health programs [4, 11]. Through the development of healthcare portals, telehealth apps, and wearable gadgets, technology is expected to play an ever-larger role in patient involvement (see Figure 1).
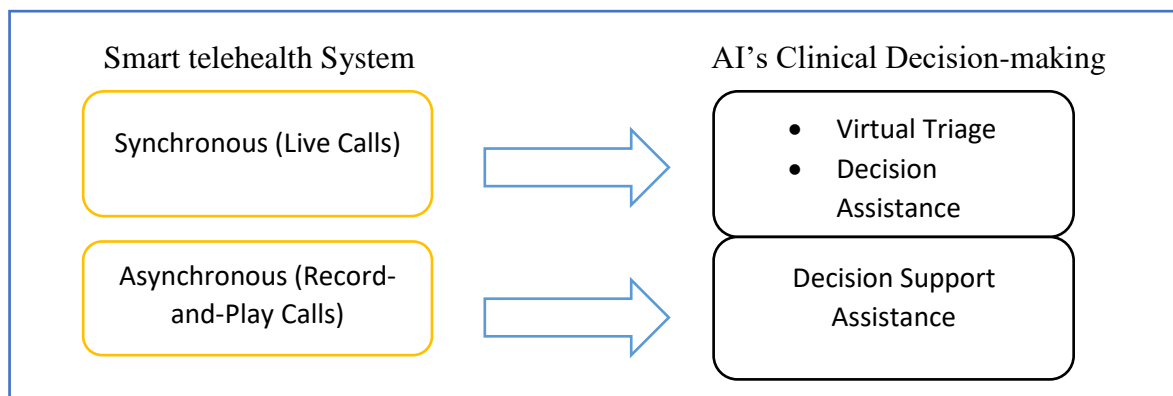

Figure 1. The expected role of AI in telehealth services.

IV. IOT AND THE INTERNET OF MEDICAL THINGS

In the world of IoT, everything is an intelligent device that is physically or virtually linked to another object or people via internet technology [12]. The Internet of Things (IoT) plays a crucial role in the healthcare system by integrating sensors and actuators in patients and their

medications for monitoring and tracking (see Figure 2). IoT gadgets in modern healthcare automatically track patients' behavior and give status updates to hospitals or insurance providers, and it is widely called as Internet of Medical Things (IMT). In other cases, IoT devices play an essential role in notifying ambulance services and hospitals when something critical happens to older people or in the event of road accidents. IBM used Radio-Frequency Identification (RFID) technology to monitor patients' usual behavior in Ohio hospitals to determine if physicians and medical workers washed their hands after treating patients frequently [13].

Whether patients are in or out of the hospital, IoT is mainly used to enhance patient care through remote monitoring and communication and to maintain track of patients 24 hours a day, seven days a week. Smart sensors, which combine a sensor and a microcontroller, make it feasible to leverage the power of the IoT for healthcare by correctly measuring, monitoring, and analyzing numerous health status indicators as support for providing healthcare anytime-anywhere grows [14]. These can include fundamental vital indicators like heart rate and blood pressure, as well as glucose and oxygen saturation levels in the blood. During the COVID-19 pandemic, hospitals in developed nations boosted their use of smart sensors in all aspects of delivery and operation to digitally give the best treatment possible. Healthcare equipment manufacturers such as GE Healthcare, Philips, IBM, Johnson & Johnson, and Abbott are conducting substantial research to produce top IoT-enabled solutions to digitalize healthcare and provide best-in-class services [13].
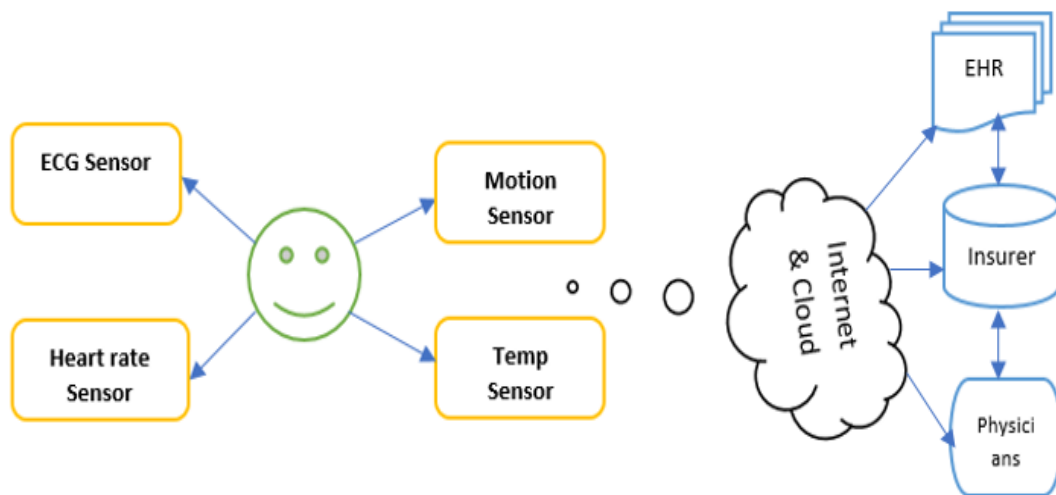

Figure 2. Use of IoT in e-health

V. CYBER RISK IN HEALTHCARE

Healthcare industries manage individuals' personally identifiable information (PII) data, thus constantly vulnerable to cyber threats. In this pandemic era, security breaches are becoming more of a worry as more people work from home [15], making healthcare the most targeted industry globally for phishing and malware assaults. While employees and their information were safely hidden behind the office firewall and out of sight of their family members, patients' personal health information is now more vulnerable since attackers now have access to improvised at-home computers [8]. As we move into the new digital era, more businesses will incorporate new policies and procedures to assist keep patients' health information safe, such as audit trails that identify who accessed what information and when. Blockchain technology is used in healthcare to avoid data breaches and security problems and increase transparency in claims payment procedures.

Due to excessive digitalization, concerns about the cybersecurity of healthcare data and medical devices are growing. Identity theft via data breach is the most common cyber-criminal activity in healthcare. Vulnerability management is a feature of artificial intelligence machines that organizations may have in their systems. According to research, about 20,362 vulnerabilities in the healthcare business were disclosed globally in 2019 [16]. More common cyber-attacks in e Healthcare are internal threats, external threats, cyber-squatting, and cyberterrorism. Cybersecurity in this industry is especially vital given the criticality of healthcare systems and the consequences of a breach or hack. While technology design is essential for cybersecurity, it is also necessary to identify the widespread insecure behaviors and anomalies in healthcare. Along with cyber risks, physical risks are also increasing in the healthcare sector, and that needs continuous improvement by training medical practitioners by improving the said classes: (a) actions of people, (b) system and technology failures, (c) accountability and process control [16].

Class	Subclass	Relation to smart healthcare
Actions of People	Learn, act, and deliberate	People and users of e-healthcare need to learn security behaviors and educate each other to avoid data breaches.
System and Technology Failures	Hardware, software, and systems	System failures, lack of regular upgrades, and miss usage led to more cyber risks. These sub-characteristics need to be closely monitored and controlled to avoid breaches.
Accountability and Process Control	Legal Issues, hazards, business issues, and process design & controls	Everyone associated with healthcare needs to understand accountability and follow the compliance process and protocols to avoid misusing data and devices.

Table 2. Cyber Risk analyzed concerning usability classes

VI. 5G AND THE UPRISING OF MHEALTH

With the advancement of 5G technology, mobile health (m-Health) is on the upswing [17]. The explosion in computer power and mobile connection has laid the groundwork for mobile health (mHealth) technologies that have the potential to change the manner and quality of clinical research and health treatment on a global scale [17]. Smartphone-connected wearable sensors, point-of-need diagnostic devices, and medical-grade imaging, all designed around real-time data streams and backed by automated clinical decision-support systems, will enable treatment and improve our knowledge of physiological variability (see Figure 3). With the advancement of nanotechnologies and the global penetration of smartphones, mHealth technologies have the potential to re-engineer practically every aspect of health care while also significantly improving our understanding of human physiology in health and illness. Financial experts believe that the market for mHealth technology would increase at a pace of approximately 55% per year, from $1.5 billion globally in 2012 to $21.5 billion by 2025 [18]. However, there is still a long way to go for mHealth. Several recent meta-analyses and systematic reviews find that high-quality evidence for using mHealth to impact behavioral changes or manage chronic illnesses, inpatient treatment, or healthcare delivery is weak [19].
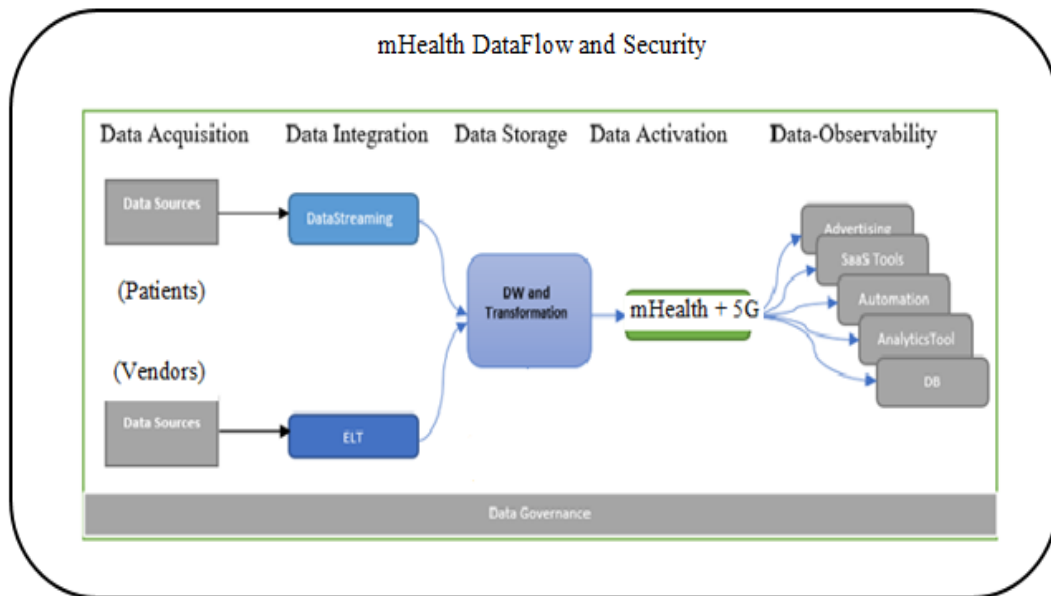
Figure 3. End-to-End mHealth data flow and security with 5G network

Obtaining the insightful data required to drive change presents both possibilities and obstacles. Designing novel clinical studies to highlight the potentially transformational nature of mHealth necessitates asking difficult questions [18]. Too frequently, mHealth technology research has been geared to address the question, "How can new technologies like mHealth fit into existing systems of care to revolutionize the healthcare industry?" It is undeniably a disruptive initiative, but it is necessary if we give the healthcare community a long-term blueprint for revolutionizing patient care.

VII.   DIGITALIZED SOCIAL SUPPORT IN E-HEALTH

Healthcare is an emotional service, and social support is critical to digitalization's success in all healthcare areas. Whether we look at Amazon, Uber, or Airbnb, these disruptive technological innovations succeed today thanks to widespread societal acceptance and change. As a corollary, e-healthcare also requires significant societal support to be a successful initiative [20]. Digitalization is bringing numerous changes to the healthcare business, but it primarily concentrates on four critical characteristics from which customers will profit directly and indirectly [21]. These elements are as follows: (a) personalized healthcare, (b) affordable healthcare, (c) integrated healthcare, and (d) seeking a good experience along the process (see Figure 4) [20].
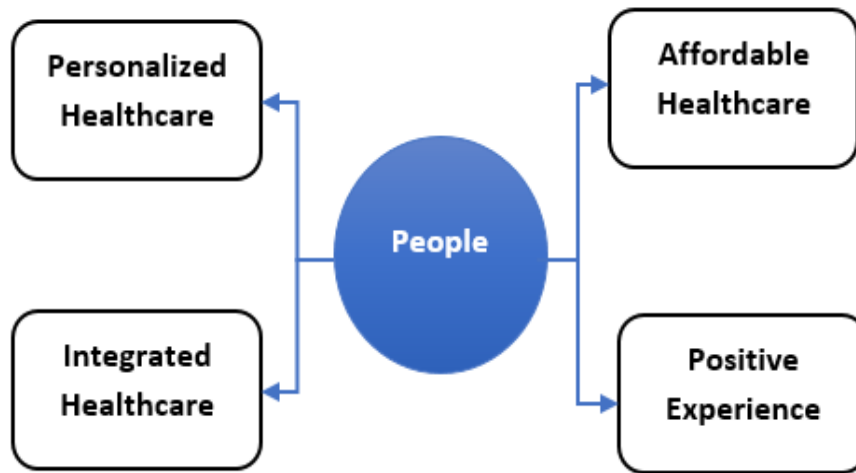
Figure 4. Societal factors of Consumer-centered smart healthcare

However, digitalized social support warrants close inspection with the growing number of online healthcare networks. Furthermore, it is uncertain whether a sort of social support has the most impact on a support seeker's psychological well-being and enjoyment [22]. Based on social support theory, this study analyzes the interactional influence of social support kinds and sources on one's well-being and happiness in a digitalized healthcare setting. Researchers and academics should look into the study's crucial implications for healthcare community managers and close family members by boosting emotional support, which leads to enhanced well-being and happiness [20, 23]. This study requires further attention to the positives and downsides of digitalized innovative healthcare and how it will affect our future.

VIII. RECOMMENDATIONS AND FUTURE WORK

Technology is continuously developing to tackle human issues [23]. This article has previously shown how the healthcare field evolved from a traditional paradigm to e-health and mHealth to serve people from home. However, many more flaws in this business were uncovered during the epidemic. Securing patient data, linking ambulance drivers to patients, automating hospital procurement, real-time updating of hospital bed management, putting up oxygen plants near hospitals, and many more instances show where we failed or were less connected with technology. As a result, this paper will serve as a foundational example of how to incorporate technology into every aspect of hospital infrastructure, not just for security but also improve client experience. This study gives scholars and data scientists more opportunities to find the loopholes in healthcare and how to make it more consumer-centered using electronics-AI interactions availing the benefits of 5G, cloud, and AI. This article calls for more deep research into the benefits and drawbacks of digitalized healthcare and how it will affect the future.

IX. CONCLUSION

The world has grown intimately connected and entirely reliant on smart healthcare briefly. The findings of this study have two consequences. On the one hand, it emphasizes understanding smart healthcare literature. On the other hand, it outlines the gaps and challenges that the healthcare business will confront due to widespread digitization in all aspects of healthcare. Despite significant advances in health innovation for global benefit, health disparities will remain an exceedingly relevant subject for healthcare practitioners in the following years due to various

government red tape worldwide. Unfortunately, inequality persists throughout our healthcare system, and the pandemic has worsened numerous long-standing gaps between multiple populations.

Moving forward, we predict that the healthcare industry will continue to interact with other sectors to benefit from digitalization. Notable technical developments have been made in recent decades and have been employed to solve health-related challenges in the healthcare industry. Our smartphones, tablets, and laptops now have medical remedies at the touch of a button. AI, IoT, and Blockchain technologies have fundamentally altered the medical profession by utilizing intelligent sensors, cloud technology, and communication technologies. The study's findings should benefit medical practitioners, students, and academics interested in intelligent healthcare.

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REFERENCES

[1] Ansari, M. F., & Dash, B. (2022). Self-service analytics for data-driven decision making during COVID-19 pandemic: An organization's best defense. Academia Letters. https://doi.org/10.20935/al4978

[2] Mageit, S. (2020, December 18). 'The Health System of the future will be consumer-centric, wellness-oriented and digitally connected'. Healthcare IT News. Retrieved October 14, 2022, from https://www.healthcareitnews.com/news/emea/health-system-future-will-be-consumer-centric-wellness-oriented-and-digitally-connected

[3] Deluca, J. M., & Enmark, R. (2000). E-health: the changing model of healthcare. Frontiers of health services management, 17(1), 3.

[4] Byham, M., & Madathil, K. C. (2015, September). Developing consumer-centered healthcare public reports: understanding the healthcare consumers' decision making process. In Proceedings of the Human Factors and Ergonomics Society Annual Meeting (Vol. 59, No. 1, pp. 1501-1505). Sage CA: Los Angeles, CA: SAGE Publications.

[5] Dash, B., & Sharma, P. (2022). Role of Artificial Intelligence in Smart Cities for Information Gathering and Dissemination (A Review). *Academic Journal of Research and Scientific Publishing| Vol*, *4*(39).

[6] Sinaiko A.D., Eastman D., Rosenthal M.B. (2012). How report cards on physicians, physician groups, and hospital can have a greater impact on consumer choices. *Health Affairs* 31(3); 602-611.

[7] Shaller D., Kanouse D. E., Schlesinger M. (2014). Context-based strategies for engaging consumers with public reports about health care providers. *Medical Care Research and Review*, 71(5 suppl), 17S-37S.

[8] Dash, B., & Ansari, M. F. (2022). An Effective Cybersecurity Awareness Training Model: First Defense of an Organizational Security Strategy.

[9] Stiggelbout, A. M., Van der Weijden, T., De Wit, M. P., Frosch, D., Légaré, F., Montori, V. M., ... & Elwyn, G. (2012). Shared decision making: really putting patients at the centre of healthcare. *Bmj*, *344*.

[10] Horne, R., Weinman, J., Barber, N., Elliott, R., Morgan, M., Cribb, A., & Kellar, I. (2005). Concordance, adherence and compliance in medicine taking. *London: NCCSDO*, *2005*(40), 6.

[11] Takahashi, D. (2020, December 8). *Deloitte's 2021 predictions: Online doctor visits will top 400 million and the pandemic will spur cloud growth*. VentureBeat. Retrieved October 14, 2022, from https://venturebeat.com/business/deloittes-2021-predictions-online-doctor-visits-will-top-400-million-and-cloud-spending-will-grow-7-times-faster-than-overall-it/

[12] Babu, B. S., Srikanth, K., Ramanjaneyulu, T., & Narayana, I. L. (2016). IoT for healthcare. *International Journal of Science and Research*, *5*(2), 322-326.

[13]Alraja, M. N., Farooque, M. M. J., & Khashab, B. (2019). The effect of security, privacy, familiarity, and trust on users' attitudes toward the use of the IoT-based healthcare: the mediation role of risk perception. *IEEE Access*, *7*, 111341-111354.

[14] Kodali, R. K., Swamy, G., & Lakshmi, B. (2015, December). An implementation of IoT for healthcare. In *2015 IEEE Recent Advances in Intelligent Computational Systems (RAICS)* (pp. 411-416). IEEE.

[15] Dash, B. (2022) REMOTE WORK AND INNOVATION DURING THIS COVID-19 PANDEMIC: AN EMPLOYERS' CHALLENGE.

[16] Coventry, L., Branley-Bell, D., Sillence, E., Magalini, S., Mari, P., Magkanaraki, A., & Anastasopoulou, K. (2020, July). Cyber-risk in healthcare: Exploring facilitators and barriers to secure behaviour. In International Conference on Human-Computer Interaction (pp. 105-122). Springer, Cham.

[17] Janda, M., Loescher, L. J., & Soyer, H. P. (2013). Enhanced skin self-examination: a novel approach to skin cancer monitoring and follow-up. *JAMA dermatology*, *149*(2), 231-236.

[18] Free, C., Phillips, G., Galli, L., Watson, L., Felix, L., Edwards, P., ... & Haines, A. (2013). The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. *PLoS medicine*, *10*(1), e1001362.

[19] Steinhubl, S. R., Muse, E. D., & Topol, E. J. (2015). The emerging field of mobile health. *Science translational medicine*, *7*(283), 283rv3-283rv3.

[20] Wang, W., Shukla, P., & Shi, G. (2021). Digitalized social support in the healthcare environment: Effects of the types and sources of social support on psychological well-being. *Technological Forecasting and Social Change*, *164*, 120503.

[21] Menvielle, L., Audrain-Pontevia, A. F., & Menvielle, W. (Eds.). (2017). The digitization of healthcare: new challenges and opportunities.

[22] Dash, B., Ansari, M. F., & Sharma, P. (2022) FUTURE READY BANKING WITH SMART CONTRACTS-CBDC AND IMPACT ON THE INDIAN ECONOMY.

[23] Kreps, G. L., & Neuhauser, L. (2010). New directions in eHealth communication: opportunities and challenges. Patient education and counseling, 78(3), 329-336.