

Empowering Digital Transformation through AI, Big Data and Cloud Computing in Ethical Way for Electronic Health Record Management

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ABSTRACT

Empowering Digital transformation in healthcare organizations is bringing a fresh perspective for healthcare delivery. Digital transformation can create innovative healthcare systems that increase access and consistency of patients care with automation, security and data driven insights. One such insight is EHR system. A patient's medical record stored digitally is called an Electronic Health Record (EHR). In this research paper, we are suggesting a centralized electronic patient file management system and a system Architecture for EHR in place of a paperback system. The proposed EHR system contains every healthcare providers such as hospitals, pharmacies, laboratories, health insurance companies, private clinics under a single system where all the data is stored and accessed by the relevant authorities. However, it has some shortcomings in terms of storage, security, and privacy. We are therefore suggesting a system that combines cloud computing, artificial intelligence, and big data to address these shortcomings. Security and privacy will be guaranteed by storing patient records on a Cloud from the time before birth until after death. All these data shall be stored and accessed in an ethical manner for data privacy and data protection. An AI-powered keyword search methodology is suggested for locating pertinent data in the EHR's Big Data.

Keywords: Cloud computing, Ethical, Electronic health record (EHR), Artificial intelligence (AI), Big data.

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1. INTRODUCTION

In this 21st century, world has seen one of the major pandemics in centuries which is COVID-19 pandemic. This COVID-19 pandemic has created a concern on healthcare system throughout the world due to mismanagement and worst preparation for healthcare pandemic. During which, World Health Organization (WHO) played a vital role in co-ordinating and monitoring the global healthcare system. Only a few countries in the world were able to manage this COVID-19 pandemic effectively and efficiently by its healthcare system. China, India and USA are only handful countries who successfully managed the COVID-19 situations by handling patients, ventilators, masks, surgical equipment's and other hospital facilities. Even today, most countries in the world do not have a centralized digital Electronic Health Record (EHR) management system to counter the similar situation in future. Henceforth this research paper focus on creating, developing and implementing footsteps for establishing EHR system in an ethical way. There is a say, which is "Prevention is better than cure", so this EHR healthcare management system will eliminate the challenges faced in today's healthcare sector. Health care upliftment is the one of the key basic human needs for better existence.

Health care is the enhancement of health through prevention, analysis, medication, betterment, or cure of disease, illness, injury, and other physical and mental restrictions in humans. Health care is provided by their professionals and allied institutions either it is private or government institutions. Health care consists of hospitals, clinics, pharmacies, nursing, pathology labs etc. Health care facilities may vary from countries to countries due to socio economic conditions, government health policy and its implementation at the ground level reaching every citizen. The Move from paper based medical records to electronic systems has gained unparalleled drive for empowerment of Healthcare using Cloud Computing, Big data and Artificial intelligence. This shift brings forth a digital transformation in the healthcare industry, bring transparency ethically.

Our proposal is an electronic health record system that will incorporate patient data from before birth (data about prenatal and postnatal fetuses, as well as Vitro fertilization (IVF history) to after death (data from autopsy, landfill etc). This data should be collected and stored continuously and electronically over time, hence improving healthcare efficiency. It is necessary to record each visit to the healthcare providers into the EHR System. The prospective advantages linked with EHR systems are public healthcare management, online patient access, and patient's medical data sharing which has drawn the interest of the research community. Ease of access to all data in a patient's file history improves care, focuses on data, thus reduces medical diagnostic errors due to lack of data availability at crucial moments. Every system has certain drawbacks EHR System also has threats such as Privacy, security, technology and Storage. To overcome this drawback this paper proposes a digital transformation of EHR system through Artificial intelligence (AI), Cloud computing and Big Data.

Cloud Computing management is a computer technology which enables users to store the data and access it over the internet instead of depending on the local servers and hardware. It provides the required services on demand like storage, database, hardware, networking, software and many others. Users can avail these services from anywhere, any device, any time with an internet connection. Integrated Health records are stored in the Hybrid Cloud platform where it combines both public and private clouds in a single platform. Private clouds are used exclusively for storing their internal health records for enhanced security and privacy. Public clouds are used over the public internet and can be shared with multiple users for accessing the health records of patients. The capability and benefits of Cloud Computing in EHR are it reduces software and hardware installation and maintenance costs; it provides high security and privacy of the data uploaded to the storage and during download of the said data. Privacy and security in cloud platforms are maintained through certain ways. Those ways are encryption and decryption of the data uploaded into the EHR cloud storage. The encryption can be Character-based encryption, private key encryption or unique encryption.

The healthcare data stored in the cloud platform are considered as a big data. Big data is large, distinct sets of information that keep on growing at higher rates. Data from medical equipment especially the wearables which are continuously worn, record high velocity data which requires fast processing in a specific data source, the value may be limited but in public sector it may get maximized value through fusion of EHR. EHR contains real time data which are bio-medical signals (ECG, pulse oximetry, Blood pressure etc.) collected from different places and stored in Cloud computing Storage system. But searching through these enormous data sets for a required specific data is hectic and time consuming. So, we propose a keyword search algorithm where the required files of the patients are searched using the Artificial intelligence technology. Artificial intelligence is improvement of computer systems which can execute tasks that require human intelligence. This reduces the time consumed to obtain the file and the accuracy of the data present in the file. Also, firewall provides the necessary security on healthcare data management. WHO also emphasized the significance of sharing healthcare data related to COVID-19 like number of cases statistics, vaccination rate and cured patients. Health care information management system facilitates the correct vaccination efforts. Also, these kind of healthcare data can be utilized by medical research institutes to develop new vaccinations and medicines. Current medical care research finds that even after 3 years post-pandemic, there are no health record management system implemented at national level for future health emergencies and preparedness. These drawbacks can be effectively tackled by a simple EHR system in place. This paper highlights the potential advantages and drawbacks and also provides the EHR system Architecture for effective Realtime implementation ethically. All medical fraternity should come together for the benefit of all humankind by bringing this EHR system to reality.

2. LITERATURE REVIEW

Artificial intelligence in healthcare: transforming the practice of medicine. This paper discusses the possible coming path of AI-augmented healthcare systems and sums up the current advancements in the application of AI in healthcare. It also illustrates a roadmap for developing safe, reliable, and productive AI systems (Bajwa, 2021).

Digital Transformation in Healthcare: Technology acceptance and its application. This paper analyses the transformations taking place in the field of healthcare due to digital transformation for which a methodical bibliographical study is performed on Scopus, Science direct and PubMed databases (Stoumpos, 2023).

The Role of Artificial Intelligence in Healthcare: A Systematic Review of Applications and Challenges. The uses and obstacles of artificial intelligence (AI) in healthcare are assessed systematically in this research paper. Regardless of the potential benefits, there are a few problems that must be overcome before AI can be fully integrated into healthcare. These comprise issues with data security and privacy, moral and lawful concerns, interoperability and challenges, scalability and accessibility issues, and the difficulties of networking with humans and AI (Udegbe, 2024).

The role of digital transformation in improving the efficacy of healthcare: A systematic review. This paper states that there is no comprehensive analysis on the application of DT in healthcare systems, despite a steadily increasing corpus of research material on the use of new technologies in healthcare. We think it's crucial to close this vacuum in the literature by conducting a study of the relevant literature, particularly from the perspectives of applications, advantages, possibilities, and threats to assess the state of these implementations and their effects on healthcare systems. We decided to conduct a systematic literature review because it is a methodology that offers transparency in data collection and results with a higher level of objectivity and reproducibility. It reviews prior literature and brings the field together with rigor, concision, and minimal room for subjectivity (Dionisio, 2022).

A Review of the Role and Challenges of Big Data in Healthcare Informatics and Analytics. Given that medical societies are recognized for their size, diversity of complexity, and high level of dynamism, big data has a significant impact. In recent years, big data has been debated from several angles, defending its role in numerous areas, particularly those pertaining to the healthcare system. Spreading health care requires assembling health information, exchanging data, and integrating health. Furthermore, as the data must be accessible from several locations inside the distributed system, data security and privacy are essential. The purpose of this paper review is to comprehend big data's involvement in healthcare challenges. combining data and the difficulties posed by big data in the medical field (Hamaamin, 2022).

The Future of EHR Systems in Healthcare: Trends and Innovations. This paper proposes

the innovations in AI, cloud computing and telehealth integration into the EHR systems which helps in driving improvements in care for patients and operational efficiency of the healthcare providers. Every healthcare provider like hospital, clinic owners, specialty doctors, pharmacists, pathologists must be up to date about the trends to make strategic decisions that will benefit the patients. It also provides challenges healthcare professionals face with EHR systems and the key trends which helps in the formation of the EHR systems .

Understanding Cloud-Based EHR Platforms and Their Benefits. This paper summarizes the benefits of Cloud based EHR platforms and understanding it. It states that cloud based EHR platforms holds the key in scalability for provider organizations. On-premises HER systems is a system that is hosted locally and present within the healthcare facilities. This is managed locally. This paper also establishes On-premises versus cloud-based EHR systems which is also known as client-server EHRs which often needs high initial hardware and software costs for on-premises EHR systems which in turn may strain the healthcare organization's budget (Mistry C, 2021).

Big Data in Health Care: Applications and Challenges. This paper review summarizes the characteristics, applications, difficulties and analysis approaches of Big Data in healthcare. Big data has some of features heterogeneous, incompleteness, longevity and timeliness, proprietorship and privacy. This brings a series of challenges such as data mining and sharing for health-related research, data storage. To overcome these challenges certain approaches which focuses on Big Data in healthcare needs to be developed and laws and regulations to use big data in healthcare needs to be setup. From patient's view application of analysis on Big Data brings improved treatment and reduces the costs of the healthcare system (Salto-Tellez M, 2019).

The use of Big Data Analytics in healthcare. This paper aims in analysing the possibility of using Big data analytics in healthcare. Introducing Big data analytics in healthcare will help both patient's treatment and healthcare management. It provides a literature review of direct research on the usage of Big Data analytics in the healthcare institutions. Direct research states that healthcare institutions are favouring data-based healthcare as it is structured and unstructured data, where reach for analytics in the administrative, clinical and business sectors of healthcare facilities. The data from sensors, different wearable devices from databases, transaction data and unstructured content of emails and documents can be distinguished in the healthcare facilities (Verma P, Sood S. K, 2018).

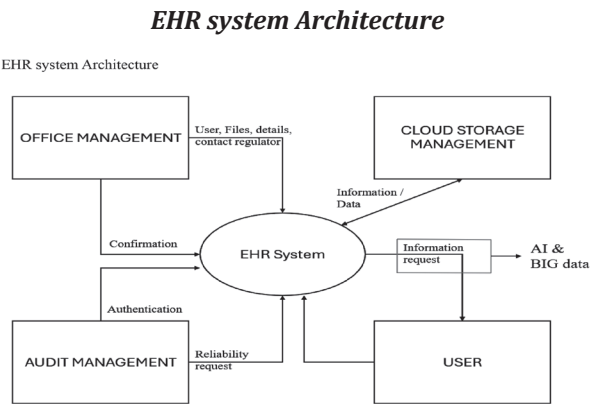
Transforming healthcare with big data analytics and artificial intelligence: A systematic mapping study. A vast amount of data is generated in different sectors of healthcare industry: data from hospitals and healthcare providers, medical insurance, medical equipment, life sciences and medical research. With the advancement in technology, there is a huge potential for utilization of this data for transforming healthcare. The application of analytics, machine learning and artificial intelligence over big data enables identification of patterns and correlations and hence provides actionable insights for improving the delivery of healthcare. There have been many

contributions to the literature in this topic, but we lack a comprehensive view of the current state of research and application. This paper focuses on assessing the available literature to provide the researchers with evidence that enable fostering further development in this area. A systematic mapping study was conducted to identify and analyse research on big data analytics and artificial intelligence in healthcare (Mendelson D, 2017).

3. METHODOLOGY

The methodology for digital transformation through AI, BIG data and cloud computing establish a high-level approach for defining a EHR system Architecture that can be implemented into a user-friendly technology development. This paper methodology objective is to clarify how AI and Cloud storage can be achieved in the effective EHR management. Also, user requirements for data access, information storage and management. These EHR system Architecture design should be reliable and effective such as AWS (Amazon warehouse services), Azure or Google Cloud for implementation to the larger and scalable model that are applied to entire country and the world. One of the key challenges for AI implementation is its automation and analytics for making decision. This could be overcome by technology provider for this architecture. In-addition, Audit protocols for relevant regulations compliance and implementation system are available and easily integrated with EHR system. Continuous improvement is the key to collect user feedback so that processes and tools can be refined for best performance and technology adaptation. Henceforward, this below established architecture for EHR system can help to create organized healthcare system that leverages AI, BIG data and Cloud computing to enhance healthcare management with audit protocols. These makes user friendly EHR system.

Figure 1



The above proposed EHR system architecture has four main blocks, they are Office management, Cloud Storage Management, User and Audit Management. These are explained in detail below:

Office Management: This is the part where users are registered by the officers into the EHR system. The key parameters of the office healthcare management system are well-defined patient management model, communication mode, roles and responsibilities of staff, financial management, management of resource and continuous training development plan. An efficient office management methodology is the vital for successful implementation of this complete framework in EHR system. Office health care management system involves unique challenges and constraints due to sensitive health information's. Hence a clear and precise structured approach is required to manage the critical office healthcare setup. Also, a user friendly and supportive healthcare office management helps both staffs and patients. This office management should be controlled, regulated and monitored by government institutions for better control of government healthcare policies to reach every people of its county. Private-Public partnership is another viable option for handling such critical management system.

The accessibility and assigning of the level of access into EHR system is provided by the office manager. According to the credibility of the users the access grade is established for example: patients can only access their medical history and are restricted to access any other data in the EHR system. Doctors will have access to upload a patient's data, but once uploaded the doctor cannot manipulate the files in the system. Similarly, pharmacy, laboratories and any other healthcare organization will have their grades of access.

Cloud Storage management: The information of the patients from birth till death is stored in the Cloud storage using the EHR systems. Hence to maintain the security and privacy of the patient's information Cloud Storage is used. According to the user necessity the companies can select the cloud storage management system required. Cloud storage is of different types such as infrastructure as a service, platform as a service and software as a service. To maintain a cloud storage environments, different applications and platforms are used. In Cloud there is pay as you use service which helps to reduce the cost of the entire EHR system.

User: Users can be patients, Doctors, Insurance companies, pharmacies, Laboratories, private clinicians or any one from the Healthcare industry. According to the access grades given by the admin at the time of registration the users can access the files in the cloud storage. Using certain keywords, the users can access the information in the EHR system. The Keyword search can be done using the artificial intelligence algorithm. Keyword Search is used to Search the file by the user. When a user needs to search a file the keyword in the file is inserted in the search program on the AI tool.

AUDIT Management: This is used to check the authenticity of the file downloaded/ accessed by the users. This keeps track of the files uploaded, viewed and edited by the users according to their credibility. If there is any discrepancy in the files on the EHR system, the Audit management informs the office management where the office management takes care of the threats.

4. RESULTS

The EHR system integration with office management, audit Management, User, Cloud storage management, AI & BIG data helps in creating the effective and efficient healthcare governance with healthcare centralized system for tracking and monitoring the health of every citizen in any country.

The technology involving AI, BIG data and Cloud computing facilitates the easy integration and implementation of EHR system throughout the world. Cloud Computing in EHR helps to maintain the Security and privacy of the files in the EHR system. The proposed EHR system has graded access to the users which helps to maintain the privacy of the different users and can limit the access the of the users according to their grades. Advantages of Cloud computing for EHR implementation are security, privacy, scalability where possibility of development is high , high performance, quality structure, flexibility, data sharing ability, interoperability, ability to search and explore while reducing the errors and improving the quality of the system.

One of challenges in Cloud computing is administrative support, so we have proposed office management. Office Management help in regulating the personal information, user access, files are managed and maintained during the EHS execution seamlessly.

5. DISCUSSION

EHR system integration with all technology is the challenging subject which needs to be worked out by the future researcher from technology background to make it feasible by establishing the conceptual best method. Creating these conceptual best EHR system will help further investigate the development of detail EHR systems that can be applied through the world.

The medical fees charged by private medical institutions will be less exploited with the use of centralized payment systems. These enable the provision of transparent medical care to everyone in the nation by bringing consistent medical fee for different treatments.

In addition, there is always a necessity for healthcare data sharing, developing health information management system, stringent guidelines, protocols for pandemic preparedness, pandemic monitoring, evaluation methodologies and global medical care collaboration for the betterment of human mankind. These efforts primarily aimed to improve public health and ensure records, information and system can counter COVID-19 or similar pandemic in efficient manner digitally.

6. CONCLUSION

This paper brings through a digital transformation by integrating AI, BIG data and Cloud management system into the EHR system. Furthermore, it empowers every person for a shared health management system for an effective and efficient healthcare system. There are always concerns about privacy and security, but these can be addressed by utilizing emerging technologies such as AI, BIG data, and cloud storage systems.

Below are the key conclusion points on this research study, they are:

- » Centralized patient medical history helps doctor in diagnosing the root causes for diseases and allergies.
- » Medical insurance can be linked for this EHR system for easy accessibility of medical files and claim history and reduce the chances of false insurance claims.
- » Medical records, prescriptions, patient information's are safeguarded due to storage of files in cloud platform. In-addition, this also helps high level cyber security at national medical data security.
- » All files in EHR systems are related to healthcare, which helps in detail research for medicine and research in diseases.
- » Patient's medical records play a vital role for getting immediate treatment during emergencies.
- » Health care information management system facilitates in developing the correct vaccination and medicine by medical research institutes or used by pharma companies throughout the world.

REFERENCES

- Bajwa, J., Munir, U., Nori, A., & Williams, B. (2021). Artificial intelligence in healthcare: Transforming the practice of medicine. *Future Healthcare Journal*, 8(2), 1–7. <https://doi.org/10.7861/fhj.2021-0095>.
- Batko, K., & Ślęzak, A. (2021). The use of big data analytics in healthcare. *Journal of Big Data*, 8(1), Article 53. <https://doi.org/10.1186/s40537-021-00553-4>.
- Dionisio, M., Pellanda, P. C., Paula, F., & De Souza Junior, S. J. (2022). The role of digital transformation in improving the efficacy of healthcare: A systematic review. *High Technology Letters*, 28(3), 1–10. <https://doi.org/10.1016/j.hitech.2022.100442>.
- Hamaamin, M. Y., Fatah, C. A., & Awrahman, B. J. (2022). A review of the role and challenges of big data in healthcare informatics and analytics. *Journal of Healthcare Engineering*, 2022, Article 5317760. <https://doi.org/10.1155/2022/5317760>.
- Hong, L., Luo, M., Wang, R., Lu, P., Lu, W., & Lu, L. (2018). Big data in health care: Applications and challenges. *Data and Information Management*, 2(3), 175–182. <https://doi.org/10.2478/dim-2018-0014>.
- Kelly, C. J., Karthikesalingam, A., Suleyman, M., Corrado, G., & King, D. (2019). Key challenges for delivering clinical impact with artificial intelligence. *BMC Medicine*, 17(1), Article 195. <https://doi.org/10.1186/s12916-019-1426-2>.
- Leu, F.-Y., Ko, C.-Y., You, I., Choo, K. K. R., & Ho, C.-L. (2018). A smartphone-based wearable sensor for monitoring real-time physiological data. *Computers & Electrical Engineering*, 65, 376–392. <https://doi.org/10.1016/j.compeleceng.2017.06.031>.
- McCarthy, J. (1998). *What is artificial intelligence?* Retrieved from <http://www-formal.stanford.edu/jmc/whatisai.html>.
- Mehta, N., Pandit, A., & Shukla, S. (2019). Transforming healthcare with big data analytics and artificial intelligence: A systematic mapping study. *Journal of Biomedical Informatics*, 103, Article 103311. <https://doi.org/10.1016/j.jbi.2019.103311>.
- Mendelson, D. (2017). Legal protections for personal health information in the age of big data: A proposal for regulatory framework. *Ethics, Medicine and Public Health*, 3(1), 37–55. <https://doi.org/10.1016/j.jemep.2017.02.005>.
- Mistry, C., Thakker, U., Gupta, R., Obaidat, M. S., Tanwar, S., Kumar, N., & Rodrigues, J. J. P. C. (2021, June 14–23). MedBlock: An AI-enabled and blockchain-driven medical healthcare system for COVID-19. *Proceedings of the IEEE International Conference Communication*, Montreal, QC, Canada, 1–6.
- Nelson, H. (2023). *Understanding cloud-based EHR platforms and their benefits*.
- Quinn, T. P., Sanader, M., Jacobs, S., Coghlan, S., & Le, V. (2021). Trust and medical AI: The challenges we face, and the expertise needed to overcome them. *Journal of the American*

Medical Informatics Association, 28(4), 890–894. <https://doi.org/10.1093/jamia/ocaa346>.

Salto-Tellez, M., Maxwell, P., & Hamilton, P. (2019). Artificial intelligence: The third revolution in pathology. *Histopathology*, 74(3), 372–376. <https://doi.org/10.1111/his.13760>.

Stoumpos, A. I., Talias, M. A., & Kitsios, F. C. (2023). Digital transformation in healthcare: Technology acceptance and its applications. *International Journal of Environmental Research and Public Health*, 20(4), Article 3407. <https://doi.org/10.3390/ijerph20043407>.

Topol, E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine*, 25(1), 44–56. <https://doi.org/10.1038/s41591-018-0300-7>.

Udegbe, F., Ebulue, O. R., Ebulue, C. C., & Ekesiobi, C. (n.d.). The role of artificial intelligence in healthcare: A systematic review of applications and challenges. *International Medical and Scientific Research Journal*, 4(4). <https://doi.org/10.51594/imsrj.v4i4.1052>.

Verma, P., & Sood, S. K. (2018). Cloud-centric IoT-based disease diagnosis healthcare framework. *Journal of Parallel and Distributed Computing*, 116, 27–38. <https://doi.org/10.1016/j.jpdc.2017.11.018>.