FRAMEWORK FOR UNDERSTANDING THE IMPACT OF MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE IN HEALTHCARE INDUSTRY

Debopam Raha[1] and A Seetharaman[2]

[1]SP Jain School of Global Management, India
[2]SP Jain School of Global Management, Singapore

ABSTRACT

This paper studies how artificial intelligence (AI) and machine learning (ML) have an impact on healthcare service delivery, specifically on patient care. The study investigates the key factors that impact in different areas of health service and develops a framework to understand the impact of each of the factors on AI adoption. A detailed literature review on AI in healthcare is performed first by looking into the journals and articles published in last two years. A conceptual framework is then developed based on the findings and the gaps identified in the literature. Five independent variables are identified: data governance, workforce competency, patient voice, predictive medicine, security and privacy. Five sub variablesunder each of the dependent variables are further identified and a conceptual framework is developed to measure patient experience. This work provides a novel framework integrating different factors while discussing several barriers and benefits of AI-ML based health. The paper then looks into how the factors have an impact on AI adoption in Indian Healthcare scenario. Further quantitative study can be done to establish the relationship between the factors and establish the validity of the model.

KEYWORDS

Artificial Intelligence, Machine Learning, Healthcare, Data Governance, Workforce Competency, Patient Voices, Predictive Medicine

1. INTRODUCTION

The role of artificial intelligence (AI) in healthcare has been the subject of intense discussion and research in recent times and there is no slowing down of the adoption of this technology. AI in healthcare has a huge and wide-reaching potential with everything from remote healthcare, disease diagnosis and drug discovery falling under the different use cases of machine learning. That being said, its acceptance to stakeholders is still low due to a variety of reasons like privacy, algorithmic clarity, data integrity or the unfortunate presence of data in silos making data sharing extremely difficult. Accountability and AI are divided between the technology literate and illiterate; and cybersecurity for privacy, data security, loss of managerial control, job loss are some of the challenges in AI adoption (Lee & Yoon, 2021). In order to use AI safely and effectively in medical care, it is necessary to work together not only to develop AI models but also to deploy it effectively. It's time to move from silo model development to designing, implementing, and evaluating in vivo AI-enabled solutions for healthcare (Li, et al. 2020). Workforce competency and understanding to trust AI systems is another factor that plays a prominent role in the adoption of AI in healthcare.The size of the Indian healthcare market is

David C. Wyld et al. (Eds): AIAA, DPPR, DSA, ICSS, IOTE, NLPTA, WEST, CACIT, BMLI- 2022
pp. 195-207, 2022. CS & IT - CSCP 2022 DOI: 10.5121/csit.2022.122315

expected to grow from $280 billion in 2020 to $372 billion in 2022 (Dash, 2020). Key challenges in India are accessibility, remote access, urban rural divide, and affordability, and these have been corroborated in studies by Dash (2020), Sainger (2021), and Roy (n.d.). This makes it all the more important to bring digital technology interventions to improve the healthcare services, especially in rural India. A conceptual framework to understand the antecedents of AI in healthcare services in India has been developed in the paper through a thorough literature review.

2. LITERATURE REVIEW

A detailed literature review in the period of 2020–2022 has been undertaken as part of the research for the paper. In the study by Li et al. (2021), predominant usage of ML in telemedicine and disease diagnosis is examined. The same is corroborated in a study by Lee and Yoon (2021), where results indicate that major hospitals in the US, UK, and Korea are at present using AI-enabled systems to help medical personnel diagnose and treat patients with a variety of diseases. In addition, AI systems help improve the efficiency of nursing and management activities in hospitals. Major opportunities, Lee and Yoon concludes, are in disease treatment, improving patient engagement, medical error reduction, operational efficiency improvement, productivity increase, and reduced healthcare cost. The study also highlights challenges: accountability, AI divide between technology literate and illiterate, cybersecurity for privacy, data security, loss of managerial control, and job loss. Another area of AI application is using natural language programming (NLP) to extract patient comments in natural texts on tests and treatments, cleanliness, administration and logistics, doctors, staff, reputation, and loyalty (GuneySenem et al., 2020). This has been an important development post COVID-19. While improving patient care as a key outcome of AI/ML has also been found in the literature review study by Shaheen (2021), who also highlighted additional areas like drug discovery and clinical trials as other potential areas of AI/ML applications. In the paper by Secinaro et al.(2020), five broad clusters were identified in healthcare applications: predictive medicine, patient data management, healthcare services management, disease diagnostics and, finally, clinical decision-making. An important point is raised by Li et al. (2020) in their paper that AI is yet to deliver at scale and provide continuous value in real world for patient services. This can happen when focus shifts not just in creation but also in real world delivery of AI.

AI helps in disease diagnosis, but algorithmic variables need to improve. Currently, there are some gaps that can be investigated as future research areas, especially in the areas of ethics, data governance, and competency healthcare professional workforce. Also a quantitative analysis of the costs and benefits generated by healthcare institutions using AI technology needs investigation (Rong et al., 2020).

Ease of interpretation of the AI logic is one of the most debated topics when it comes to the application of AI in healthcare. However, this is not a purely technology question; instead, it deals with a wide range of medical, legal, ethical, and social issues that require in-depth exploration. In the study by (Amann, 2020), the author points that more work needs to be done to educate developers, healthcare professionals, and policymakers about the challenges and limitations of opaque algorithms in medical AI and need to promote multidisciplinary collaboration to address these areas. Doctors are still waiting for proof of the usefulness of these tools and wondering if they could be held liable in the event of an injury caused by an AI tool they don't fully understand. Members of regulatory board want to be able to act as regulators, both in the development of AI tools and in the race for health data (Laï et al., 2020).
For AI to work effectively, it needs a conversation between all relevant stakeholders, without exception. So it seems that focusing on the patient's voice is all the more important. As pointed by Laï et al. (2020), further research into healthcare professionals' experiences and perceptions of

AI technology is needed. This will involve training and educating the workforce that will assist in integrating AI into care (Shinners et al., 2020).

3. RESEARCH METHODOLOGY

3.1. Research Framework and Definition of Variables

Based on the literature review, the following conceptual framework has been developed in Figure

1. The five independent factors impacting AI in healthcare service are data governance, patient voices, predictive medicine, privacy and security, and workforce training. The dependent variable identified is patient experience. Five sub variables for each independent variable have been identified, as depicted in Figure 1.

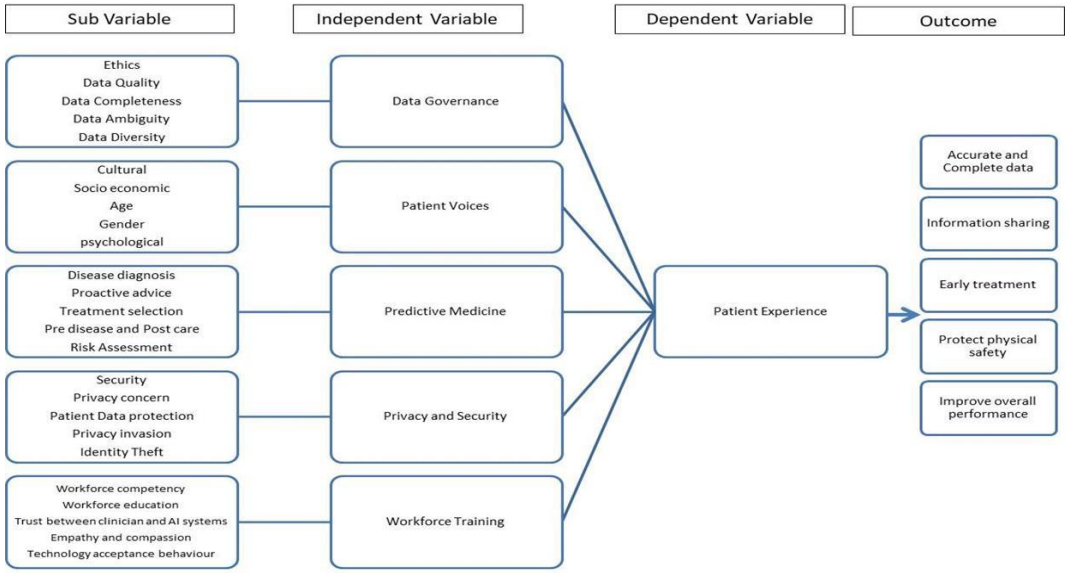

Figure 1. Conceptual framework for AI in healthcare services. Each of the independent variables are defined in the following subsections.

3.1.1. Data Governance

Successful AI algorithm in healthcare services will require a large amount of citizen/patient data collected from different sources: hospitals, pharmacies, wearables, and social sites. In addition, the opacity of AI algorithms and how they use and transform data challenges existing data protection and data governance regulations. Even the EU's General Data Protection Regulation (GDPR)is not enough to put data governance in place for personal data usage of AI for healthcare. It is expected to have data governance in place around use of AI in healthcare services.

3.1.1.1. Ethics

Responsible AI should be one of the core stances for doing AI research in healthcare. The responsibility in using ethical principles must pervade in the entire lifecycle, from conceptualization to design, development, explanation, and usage of AI in healthcare services that will impact human lives. Ethics should be a fundamental part of data governance in AI.

3.1.1.2. Data Quality

While companies are keen to leverage AI/ML to derive meaningful insights from the vast amount of data they own, the accuracy of AI/ML models depends on the amount and quality of data used for training and validation sets. Inaccurate input data can lead to misleading results from the AI /ML model. Therefore, it is imperative to ensure high data quality in AI/ML-based data processing through data treatment, data cleaning, and master data analysis.

3.1.1.3. Data Completeness

In addition to quality and volume of data, another factor under data governance is the completeness of data. By data completeness, we mean the comprehensiveness of the data. It can be measured by the number of missing entries in the data collection and whether they have a meaningful impact on the outcome of the algorithm.

3.1.1.4. Data Ambiguity

Data in healthcare is mostly unstructured (e.g., patient voices, doctors' notes), noisy, and ambiguous. This makes it difficult for AI algorithms to get meaningful insights unless the data is transformed and structured. Removal of data ambiguity should be one of the key sub factors in data governance

3.1.1.5. Data Diversity

A meaningful insight in AI will come when data is collected without bias and from diverse background, race, gender, and ethnicity. Data collection and processing should be carried out by teams with different experiences, backgrounds, ethnicities, races, ages, and perspectives. People in developing countries in Asia have different views than those in western countries.

3.1.2. Patient Voices

As the objective of AI in healthcare is to build machines that use data to help diagnose and treat patients, humans/patients should be at the center of AI design. The AI algorithms need to ultimately absorb everything the patient says, what the patient is experiencing, and the emotions they express in developing cluster maps/natural language processing. Patient voices will be dependent on sub factors like culture, socio economic status, age, gender, and psychological aspects.

3.1.2.1. Cultural

Cultural factors will have a significant impact on how AI is used in healthcare. Affordability, educational and social status, and medical training contributes to this. The cultural perspective of clinicians and doctors during human–computer interactions, and the essential suspicion of lack of human-to-human interactions can contribute to the usage or restraint in adopting AI in routine medical practice.

3.1.2.2. Socio Economic

Socio-economic status will be an important sub factor under patient voices. People at a higher socio-economic scale will be more vocal and likely to provide data (through wearables and patient feedback) and this can have an impact on AI outputs and insights on patient experiences.

3.1.2.3. Age

It is expected that younger and middle-aged patients (age 25–45) will be more likely to use insights from AI-powered health apps compared to senior citizens, who will be more cautious and want a regular doctor visit. Even the younger workforce in healthcare organizations will be more likely to adopt and use AI-based insights.

3.1.2.4. Gender

While gender may have an impact toward patient voices, it needs to be studied whether this is due to other moderating factors like age or education. However, it must be considered as a sub factor under patient voices and analyzed to see the impact in healthcare AI.

3.1.2.5. Psychological

There is a psychological factor, which is preference of patients for a human doctor rather than getting inputs from a machine for healthcare diagnoses. They may be less reluctant in using chat bots for grievances and other non-clinical AI. It is therefore an important subfactor under patient voices.

3.1.3. Predictive Medicine

One of the important applications for AI in healthcare is disease diagnosis by comparing thousands of medical records, experiencing automatic learning with clinical alerts. The patient experience around predictive medicine is an important factor to be considered in the conceptual framework.

3.1.3.1. Disease Diagnosis

In the paper by Rong et al. (2020), the authors reviewed the latest developments in the application of AI in biomedicine, including disease diagnostics and prediction, living assistance, biomedical information processing, and biomedical research.Accurate disease diagnosis using AI will help physicians to get back to patients faster thereby improving patient experience.

3.1.3.2. Proactive Advice

In the long run, AI will shift healthcare from reactive to proactive care. Instead of waiting until patients get sick and then receiving treatment, patients will anticipate and prevent health problems. Using AI, the healthcare system will schedule tests and screenings, identify the best treatments and doctors, and help patients manage their health proactively.

3.1.3.3. Treatment Selection

It is expected that AI-enabled systems will help clinicians in patient diagnosis and treatment selection for a wide range of diseases. This will help in better diagnosis and clinical outcome. So, treatment selection will be considered as one of the factors under predictive medicine.

3.1.3.4. Pre-Disease and Post Care

Patient monitoring is an essential element of hospital service management. With the development of deep learning algorithms, individual tracking tasks can be supplemented by AI. Even post care treatment through remote monitoring can be done through AI-enabled systems.

3.1.3.5. Risk Assessment

AI algorithms will be synthesizing medical data about patient conditions and come with individual risk assessment of a medical condition. This can help patients to understand their individual risks and outcomes, explore options, and determine next course of actions for treatment. This can help in better clinical outcomes and proactive care.

3.1.4. Privacy and Security

Privacy and security of data is an important consideration for patients to fully embrace AI-based solutions and apps in their daily lives or even when communicating in hospitals. There is still hesitancy in the way the AI algorithms derive insights, how the data is used, and whether any deduplication algorithm is incorporated to remove any patient specific personal information. Under privacy and security, the main sub factors considered are security, privacy, patient data protection, privacy invasion, and identity theft.

3.1.4.1. Security

AI impact on human security will be an important sub factor, particularly when related to facial and pattern recognition using big data. AI could potentially fill gaps and mitigate risks in healthcare cybersecurity.

3.1.4.2. Privacy Concern

Key concerns around privacy are access, use, and control of patient data in private hands. Several recent public–private partnerships for AI implementation have resulted in poor privacy protection. As a result, calls have been made for more systematic monitoring of big, data-driven health research. Appropriate safeguards should be in place to protect patient and agency confidentiality. A patient's ability to de-identify health data could be compromised or even denied as new algorithms successfully re-identify that data. This may increase the risk to patient data that is being kept private.

3.1.4.3. Patient Data Protection

Although AI algorithms can be developed using anonymized or aggregated data, performing experimental research is often one of the key elements of a research project, and such research has a tendency to use personal data. While the general data protection regulation (GDPR) provides regulation around usage and restrictions on patient data, as the AI based healthcare services mature, each country will come up with their own data protection bill.

3.1.4.4. Privacy Invasion

There are also threats in privacy invasion of AI that need to be managed properly before extensive application in real world. Not only are patients worried about the personal data being used in AI algorithms but there is an added concern on how the data is used by other companies like retail, insurance for targeted advertisements, and selling services and products.

3.1.4.5. Identity Theft

As AI is increasingly integrated into clinical practice, various important challenges will persist, including data collection, notification, and the ability to re-identify patient data. A mutual benefit can be achieved, where data can be kept private while also being useful for AI in medical practice.

3.1.5. Workforce Training

Workforce training will be an important factor for determining patient experience in AI-based healthcare services. The current workforce is hesitant to use or even believe the AI-based insights developed form the algorithms and this can be removed only through training, so that the distrust is eliminated or reduced. Sub factors under workforce training are workforce competency, education, trust, empathy, and technology acceptance behavior

.

3.1.5.1. Workforce Competency

Without the workforce competency, AI-based systems will not find takers among the medical community. This competency can be improved through training, education, and bringing together AI developers and practitioners so that the opacity of AI algorithms is removed.

3.1.5.2. Workforce Education

Clinicians are generally slow in adapting to technological changes and its applicability in healthcare which needs to be improved. One of the determinants for this is training and education of the clinicians towards AI-based systems and the algorithms behind it.

3.1.5.3. Trust Between Clinician and AI Systems

No AI system will work without sufficient trust developed between the end users, be it patients or clinicians, and the AI systems. Explainable AI is an important factor to develop the trust between clinicians and the systems. Unless the algorithms or data collection processes are explained and the clinicians are convinced on its usage, trust cannot be developed.

3.1.5.4. Empathy and Compassion

AI has the potential to fundamentally change the way empathy, compassion, and trust are viewed and practiced today in healthcare. Going forward, it will be important to re-evaluate if and how these values can be integrated and practiced in a healthcare system where AI is increasingly used. More importantly, society needs to re-examine what kind of healthcare it should promote (Kerasidou, 2020).

3.1.5.5. Technology Acceptance Behavior

While previous factors like workforce competency, education, trust, and empathy will determine the acceptance of AI-based systems, a key factor to determine the usage will be the technology acceptance; how well are users ready to work with the technology and understand the science and engineering behind it? Perceived usefulness and perceived ease of use as per the technology acceptance model will be the determinants of technology acceptance behavior.

4. DISCUSSION, ANALYSIS, AND OUTCOME

In the conceptual frame work shown in Figure 1, the patient experience will be measured for each of the independent variables through a set of outcomes, as determined below.

4.1.1. Data Governance Problems and Solutions

Efficient data management processes enable business users to make decisions based on transparent and reliable data. It helps organizations not only understand what their data assets are and how to access them, but also how to use that data most effectively. The outcome for data governance factors will be measured through availability of accurate and complete data.

4.1.2. Patient Voices: Problems and Solutions

Patient voice is the practice of analyzing patient feedback in the healthcare industry. Many organizations such as clinics, hospitals, and medical facilities use and analyze this data to improve safety, quality of care, and patient experience. Active voice often focuses on the patient's needs, concerns, and demands related to the disease itself. Passive voice generally refers to feedback regarding health-related information collected from patients for specific purposes, such as assessing treatment side effects and monitoring physical signs. The outcome will be measured through effective information sharing between patient and clinicians.

4.1.3. Predictive Medicine: Problems and Solutions

A number of AI use cases are found in the area of predictive medicine. AI provides tools and models to extract information from complex and voluminous data of patients in different systems and translate them to aid in clinical decision making. The outcome for predictive medicine will be measured through early treatment.

4.1.4. Privacy and Security:Problems and Solutions

Privacy and security are linked. Privacy refers to all the rights you have to control your personal information and how it is used. On the other hand, security refers to how your personal information is protected. Here, the outcome for privacy and security concerns will be measured through physical safety measurement effectiveness.

4.1.5. Workforce Training: Problems and Solutions

Effectiveness of AI usage in the healthcare industry will not come unless the workforce is sufficiently trained to understand the intricacies of AI algorithms and adopt them in decision making. Teleworking and workforce decentralization have created new challenges in workforce training. Learners' habits and preferences are to be considered for effective design of training. The outcome will be measured by improvement in workforce performance.

5. DIGITAL HEALTHCARE AND AI MATURITY IN INDIA

As stated in a detailed study on the Indian healthcare scenario by Dash (2020), the size of the Indian healthcare market is expected to grow from $280 billion in 2020 to $372 billion in 2022. More than 74% of this is covered under private and out-of-pocket healthcare costs. There is a total of 66% of doctors in urban areas, while 66% of the Indian population is in rural areas. Key challenges of accessibility, remote access, urban rural divide, and affordability have been corroborated in studies by Dash (2020) Sainger (2021), and Roy (n.d.). This makes it all the more important to bring digital technology interventions to improve the healthcare services, especially in rural India. In their study, Seethalakshmi and Nandan (2020) mention that the biggest trigger for digital transformation in India was the COVID-19 pandemic, with staggering responses from the private sector and proactive push from the government. There is a common theme in the research studies by Sainger (2021) and Dash (2020), and that is the government's focus on

Ayushman Bharat Digital Mission (ABDM) and the creation of a health unique identification number (HUID). The KPMG report of 2021 highlights that it is equally important to uberize the referral system of the country to strengthen referral linkages, promote telemedicine services, and to expand healthcare accessibility and availability, incentivizing providers to make efforts toward digitization and integrate all existing digital applications into one. In his summary findings, Dash (2020) has mentioned five key themes for the future digital scenario in Indian healthcare. Firstly, COVID-19 has become the fulcrum for India's IoT leap in healthcare. While telemedicine and remote patient monitoring were gaining traction in India for the last two decades, the uncertainty caused by COVID-19 gave a tremendous push to digital health initiatives. Secondly, use the Make in India and Atmanirbhar Bharat mission to encourage technology start-ups in digital health space. Thirdly, Ayushman Bharat Digital Mission (ABDM) by the government of India will be a key driving factor for digital healthcare in India. Fourth, training and skilling healthcare workers in IoT and digital health technologies. Finally, change management for adoption of digital technologies in healthcare.

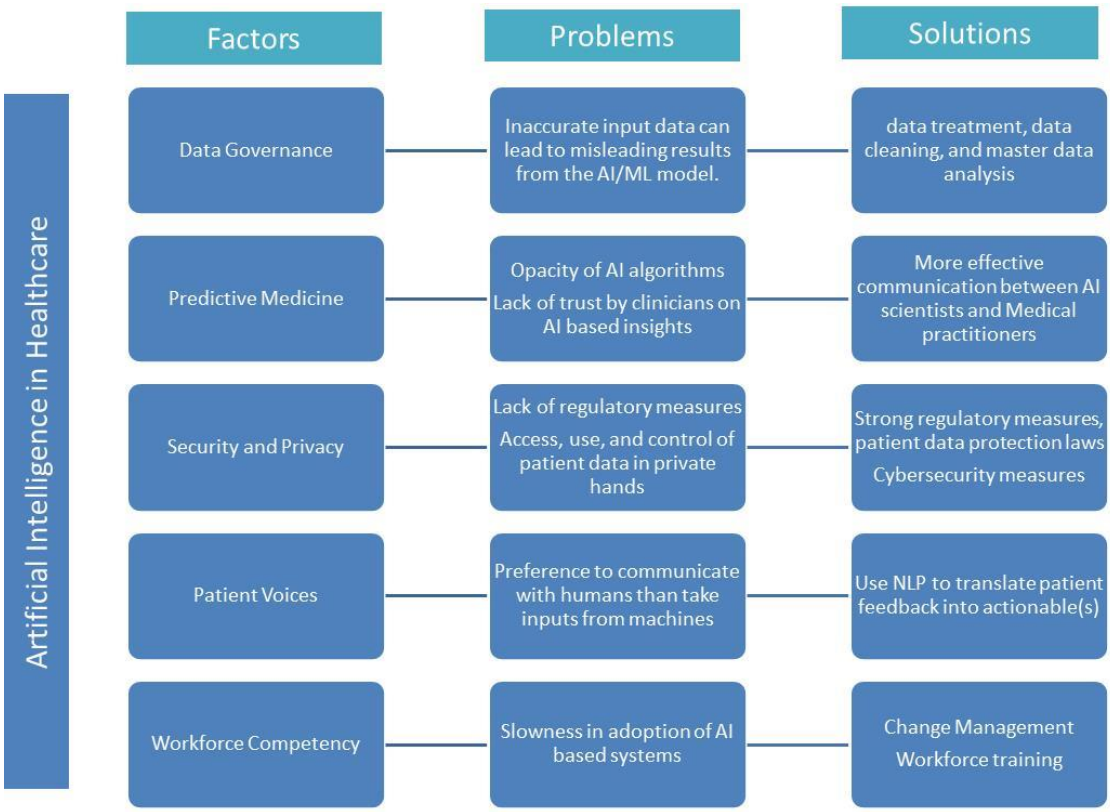

Figure 2. Factors of Conceptual framework with problems and solutions

6. RESEARCH IMPLICATIONS

There are multiple findings from the research. The key variables in favor of effective usage are data quality and governance. An illustration of the potential problems and solutions for each of the factors is given in Figure 2. Most of the organizations are trying to put effective electronic health records (EHR) systems in place so that all the clinical data is available in a structured

format. This, along with interoperability and effective exchange of data with other systems like CRM, billing data, and social media feeds will help to improve the input data quality. However, the regulations around data privacy and governance must be implemented to put controls in place and generate trust between clinicians and patients. Also, the medical industry guidelines around patient data protection must be explored.

7. LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

There are several limitations that can be areas for future research in this field. The literature review helped to develop the construct of the conceptual framework based on studies in US, Europe, and China. The impact on AI in the Indian healthcare scenario needs a detailed investigation. Furthermore, a quantitative model needs to be developed to measure the relationship between the variables. Other variables that can be considered are digital infrastructure like cloud, 5G, IoT and its impact on healthcare AI.

8. CONCLUSIONS

AI in is still at a nascent stage and the technology is evolving, as can be seen from the literature review and industry thought leadership. Future areas of work in Blockchain, Edge Computing, Deep Learning, Natural Language Processing, and Internet of Things will aid progress in AI-based algorithms especially around machine learning. However, as can be seen its acceptance and actual use is still limited to some pilot implementations in hospitals or towards customer service. Advanced use of AI in disease prognosis and preventive care is still at infancy stage. As explained in this paper, it is not technology and algorithms alone that will help in the increased adoption but human factors will play a vital role. The paper identifies five factors: data governance, workforce competency, patient voice, predictive medicine, security and privacy as critical for AI adoption. Machine Learning/AI is essentially a data science problem which needs unbiased and large sample data. Without having effective data governance in place, results will not be viable and trustworthy. Similarly, another important factor is workforce training. The current workforce distrust on the efficacy of the AI-based insights developed form the algorithms can be removed only through training. Workforce competency towards AI acceptance needs to be increased. Next factor is Patient Voices. As the objective of AI in healthcare is to build machines that use data to help diagnose and treat patients, humans/patients should be at the center of AI design and implementation. The AI algorithms need to understand what the patient says, what the patient is experiencing, and the emotions they express in developing cluster maps/natural language processing. Privacy and security of data is another important consideration for patients to fully embrace AI-based solutions and apps in their daily lives or even when communicating in hospitals. In today's world patient data privacy is of paramount importance and if the AI solutions do not have effective privacy and security layer built, the acceptance of the solutions will be low. The final factor considered is Predictive medicine. One of the important applications for AI in healthcare is disease diagnosis by comparing thousands of medical records, experiencing automatic learning with clinical alerts. Unless the prediction algorithms are industrialized, the solutions will not scale. While the paper considers these factors as important for AI adoption, it is a qualitative study at this moment. A quantitative statistical analysis through survey data will help understand the strength of the relationships. Also while the paper has focused on five factors, the effect of other variables like cloud, 5G, IoT need to be studied for any moderating or mediating effect on the factors considered here.

REFERENCES

[1] Alahakoon, D., Nawaratne, R., Xu, Y., De Silva, D., Sivarajah, U., & Gupta, B. (2020). Self-building artificial intelligence and machine learning to empower big data analytics in smart cities. *Information Systems Frontiers*, 1–20.

[2] Alotaibi, S. R. (2020). Applications of artificial intelligence and big data analytics in m-health: A healthcare system perspective. *Journal of healthcare engineering*.

[3] Amann, J., Blasimme, A., Vayena, E., Frey, D., &Madai, V. I. (2020). Explainability for artificial intelligence in healthcare: A multidisciplinary perspective. *BMC Medical Informatics and Decision Making*, *20*(1), 1–9.

[4] Asan, O., Bayrak, A. E., & Choudhury, A. (2020). Artificial intelligence and human trust in healthcare: Focus on clinicians. *Journal of medical Internet research*, *22*(6), e15154.

[5] Bharti, U., Bajaj, D., Batra, H., Lalit, S., Lalit, S., &Gangwani, A. (2020). Medbot: Conversational artificial intelligence powered chatbot for delivering tele-health after covid-19. In 2020 5th international conference on communication and electronics systems (ICCES) (pp. 870-875). IEEE.

[6] Butow, P., & Hoque, E. (2020). Using artificial intelligence to analyse and teach communication in healthcare. *The Breast*, 50, 49–55.

[7] Choudhury, A., & Asan, O. (2020). Role of artificial intelligence in patient safety outcomes: Systematic literature review. *JMIR medical informatics*, *8*(7), e18599.

[8] Fan, W., Liu, J., Zhu, S., &Pardalos, P. M. (2020). Investigating the impacting factors for the healthcare professionals to adopt artificial intelligence-based medical diagnosis support system (AIMDSS). *Annals of Operations Research*, *294*(1), 567–592.

[9] FossoWamba, S., & Queiroz, M. M. (2021). Responsible artificial intelligence as a secret ingredient for digital health: Bibliometric analysis, insights, and research directions. *Information Systems Frontiers*, 1–16.

[10] Fox, G., & James, T. L. (2021). Toward an understanding of the antecedents to health information privacy concern: A mixed methods study. *Information Systems Frontiers*, *23*(6), 1537–1562.

[11] Hercheui, M., & Mech, G. (2021). Factors affecting the adoption of artificial intelligence Inhealthcare. *Global Journal of Business Research*, *15*(1), 77–88.

[12] Houfani, D., Slatnia, S., Kazar, O., Saouli, H., &Merizig, A. (2021). Artificial intelligence in healthcare: A review on predicting clinical needs. *International Journal of Healthcare Management*, 1–9.

[13] Johnson, M., Albizri, A., &Harfouche, A. (2021). Responsible artificial intelligence in healthcare: Predicting and preventing insurance claim denials for economic and social wellbeing. *Information Systems Frontiers*, 1–17.

[14] Kerasidou, A. (2020). Artificial intelligence and the ongoing need for empathy, compassion and trust in healthcare.*Bulletin of the World Health Organization*, *98*(4), 245.

[15] Kumar, P., Dwivedi, Y. K., & Anand, A. (2021). Responsible artificial intelligence (AI) for value formation and market performance in healthcare: The mediating role of patient's cognitive engagement. *Information Systems Frontiers*, 1–24.

[16] Laï, M. C., Brian, M., & Mamzer, M. F. (2020). Perceptions of artificial intelligence in healthcare: Findings from a qualitative survey study among actors in France. *Journal of Translational Medicine*, *18*(1), 1–13

[17] Lee, D. (2018). Strategies for technology-driven service encounters for patient experience satisfaction in hospitals. *Technological Forecasting and Social Change*, 137, 118–127. https://doi.org/10.1016/j.techfore.2018.06.050

[18] Lee, D. (2019). A model for designing healthcare service based on the patient experience. *International Journal of Healthcare Management*, *12*(3), 180–188. https://doi.org/10.1080/20479700.2017.1359956

[19] Lee, D., & Yoon, S. N. (2021). Application of artificial intelligence-based technologies in the healthcare industry: Opportunities and challenges. *International Journal of Environmental Research and Public Health*, *18*(1), 271. https://doi.org/10.3390/ijerph18010271

[20] Leone, D., Schiavone, F., Appio, F. P., & Chiao, B. (2021). How does artificial intelligence enable and enhance value co-creation in industrial markets? An exploratory case study in the healthcare ecosystem. *Journal of Business Research*, 129, 849–859.

[21] Li, R. C., Asch, S. M., & Shah, N. H. (2020). Developing a delivery science for artificial intelligence in healthcare. *NPJ Digital Medicine*, *3*(1), 1–3.

[22] Manne, R., &Kantheti, S. C. (2021). Application of artificial intelligence in healthcare: Chances and challenges. *Current Journal of Applied Science and Technology*, *40*(6), 78–89.
[23] Mansour, R. F., El Amraoui, A., Nouaouri, I., Díaz, V. G., Gupta, D., & Kumar, S. (2021). Artificial intelligence and Internet of Things enabled disease diagnosis model for smart healthcare systems. IEEE Access, 9, 45137-45146.
[24] Meyer, A. N., Giardina, T. D., Spitzmueller, C., Shahid, U., Scott, T. M., & Singh, H. (2020). Patient perspectives on the usefulness of an artificial intelligence–assisted symptom checker: Cross-sectional survey study. *Journal of Medical Internet Research*, *22*(1), e14679.
[25] Mohamadou, Y., Halidou, A., &Kapen, P. T. (2020). A review of mathematical modeling, artificial intelligence and datasets used in the study, prediction and management of COVID-19.*Applied Intelligence*, *50*(11), 3913–3925.
[26] Mohanta, B., Dash, P., & Patnaik, S. (2019). Healthcare 5.0: A paradigm shift in digital healthcare system using artificial intelligence, IOT and 5G communication. *2019*
[27] Musbahi, O., Syed, L., Le Feuvre, P., Cobb, J., & Jones, G. (2021). Public patient views of artificial intelligence in healthcare: A nominal group technique study. *Digital Health*, 7, 20552076211063682.
[28] Nagendran, M., Chen, Y., Lovejoy, C. A., Gordon, A. C., Komorowski, M., Harvey, H., ... &Maruthappu, M. (2020). Artificial intelligence versus clinicians: systematic review of design, reporting standards, and claims of deep learning studies. *Bmj*, 368.
[29] Okon, E., Rachakonda, V., Hong, H. J., Callison-Burch, C., &Lipoff, J. B. (2020). Natural language processing of Reddit data to evaluate dermatology patient experiences and therapeutics. *Journal of the American Academy of Dermatology*, *83*(3), 803–808.
[30] Puri, V., Kataria, A., & Sharma, V. (2021). Artificial intelligence-powered decentralized framework for Internet of Things in Healthcare 4.0. *Transactions on Emerging Telecommunications Technologies*, e4245.
[31] Rong, G., Mendez, A., Assi, E. B., Zhao, B., &Sawan, M. (2020). Artificial intelligence in healthcare: Review and prediction case studies. *Engineering*, *6*(3), 291–301.
[32] Roy, M. (n.d.). Digital Health Evolution and propagation in Rural Healthcare in India: A Review. 19.
[33] Sainger, D. G. (2021). Digital dimension of Indian healthcare sector: A review. *Annals of the Romanian Society for Cell Biology*, 1523–1528.
[34] Scardoni, A., Balzarini, F., Signorelli, C., Cabitza, F., & Odone, A. (2020). Artificial intelligence-based tools to control healthcare associated infections: A systematic review of the literature. *Journal of Infection and Public Health*, *13*(8), 1061–1077.
[35] Scheetz, J., Rothschild, P., McGuinness, M., Hadoux, X., Soyer, H. P., Janda, M., ... & van Wijngaarden, P. (2021). A survey of clinicians on the use of artificial intelligence in ophthalmology, dermatology, radiology and radiation oncology.*Scientific reports*, *11*(1), 1–10.
[36] Secinaro, S., Calandra, D., Secinaro, A., Muthurangu, V., &Biancone, P. (2021). The role of artificial intelligence in healthcare: A structured literature review. *BMC Medical Informatics and Decision Making*, *21*(1), 1–23.
[37] Shinners, L., Aggar, C., Grace, S., & Smith, S. (2020). Exploring healthcare professionals' understanding and experiences of artificial intelligence technology use in the delivery of healthcare: An integrative review. *Health informatics Journal*, *26*(2), 1225–1236.
[38] van der Schaar, M., Alaa, A. M., Floto, A., Gimson, A., Scholtes, S., Wood, A., ... &Ercole, A. (2021). How artificial intelligence and machine learning can help healthcare systems respond to COVID-19. *Machine Learning*, *110*(1), 1–14.
[39] Wang, Y., Xiong, M., &Olya, H. (2020). Toward an understanding of responsible artificial intelligence practices. In proceedings of the 53rd Hawaii international conference on system sciences (pp. 4962–4971). Hawaii International Conference on System Sciences (HICSS).
[40] Wolff, J. (2021). Success factors of artificial intelligence implementation in healthcare. *Frontiers in Digital Health*, 3, 51.

AUTHORS

Debopam Raha is a research student pursuing Doctor of Business Administration at SP Jain School of Global Management, India. Currently he works as an Associate Partner in KPMG, India. Debopam has more than 20 years of Industry experience across US, India and Europe in large management consulting firms and have been involved in leading digital health strategy and implementation projects globally for various state, national governments and

private sector. He was a critical member in establishing the Digital Health Hub Center of Excellence set up by KPMG. His expertise includes Large Scale Technology Transformation, Business Systems Integration, Enterprise Architecture, Business and Solution Architecting. His interest lies in Digital Healthcare, Artificial Intelligence, Machine Learning, Big Data, IOT as well as understanding Business Impact and change Management through Digital Transformation He has been a public speaker in numerous health and technology conferences.

Prof. Arumugam Seetharaman is a Professor & Dean, Research at SP Jain School of Global Management. His areas of expertise include Global Business Strategy and Business Strategy & Sustainability. Dr. Seetha has more than 150 publications to his credit, including articles listed in ISI indexed journals.