OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

Real-Time Collaboration Tool for Healthcare

Prof. Ashvini Bamanikar[1] Jyotish Batra[2] Abhishek Katale[3] Saurabh Thakur[4] Ghanashyam Kadam[5]

[1]Professor PDEA's College of Engineering, Pune.
[2,3,4,5] Student PDEA's College of Engineering
Department of Computer Engineering,Pune District Education Association's College of Engineering,Manjari Bk. Hadapsar, Pune, Maharashtra, India. - 412307
ashvini.bamanikar@gmail.com, jyotishbatra2003@gmail.com, abhishekkatale427@gmail.com, thakursaurabh.work@gmail.com, ghanashyamkadam1@gmail.com
Email: coem@pdeapune.org

Abstract: ***The healthcare industry necessitates efficient platforms for real-time collaboration, knowledge sharing, and continuous professional development among healthcare professionals. Existing tools often lack the integration of artificial intelligence (AI) solutions that can enhance decision-making and predict emerging healthcare trends. This paper presents the design, development, and implementation of a Real-Time Collaboration Tool for Healthcare, aimed at addressing these challenges. The platform features doctor logins and profiles, a community forum for sharing experiences, news updates and blogs, and an AI-driven query-solving module. Utilizing a microservices architecture, WebSocket technology for real-time communication, and progressive web application (PWA) standards, the tool ensures scalability, security, and user accessibility. Preliminary results indicate enhanced communication efficiency and knowledge dissemination among users, contributing to improved patient care outcomes***

Keywords: Real-Time Collaboration, AI-Assisted Query Solving, Knowledge Sharing, Progressive Web Application.

JEL Classification Number: I10, C88, L86.

I. INTRODUCTION

The healthcare sector thrives on effective collaboration and communication among its professionals, encompassing doctors, nurses, administrators, and support staff. The complexity and interdisciplinary nature of healthcare require seamless information exchange and collaborative decision-making to ensure optimal patient outcomes. Traditional communication methods, such as emails and in-person meetings, often fall short in meeting the dynamic needs of modern healthcare environments. Existing digital tools, while facilitating some aspects of collaboration, frequently lack integration with advanced technologies like artificial intelligence (AI) that can further enhance decision-making and predictive analytics.This paper introduces a Real-Time Collaboration Tool for Healthcare designed to bridge these gaps. The platform aims to provide a secure, user-friendly environment where healthcare professionals can engage in real-time discussions, share experiences, stay updated on industry developments, and leverage AI-driven solutions for medical queries. By incorporating features such as role-based access, community forums, news updates, blogs, and an AI-assisted query-solving module, the tool seeks to foster a collaborative culture that supports continuous learning and informed decision-making.

II.LITERATURE REVIEW

Effective collaboration tools are pivotal in enhancing communication and productivity within various professional domains, including healthcare. The literature highlights significant advancements and persistent gaps in existing solutions.

2.1 Communication Tools in Creative and Healthcare Industries

Ajiva et al. (2024) conducted a comprehensive review of communication tools and techniques that enhance collaboration among creative professionals. While their focus was on the creative sector, many insights are transferable to healthcare. The shift from traditional to digital communication methods, including instant messaging platforms like Slack and Microsoft Teams, and collaborative design tools such as Figma and Trello, has revolutionized professional interactions. These tools facilitate real-time communication, project management, and knowledge sharing, which are equally essential in healthcare settings where timely information exchange can directly impact patient care.

Similarly, HP SharedX, as discussed by Garfrinkel et al., exemplifies tools designed for real-time collaboration through

application sharing over networks. Although primarily used in software development, the principles of shared interactive environments can be adapted to healthcare for collaborative case discussions and joint diagnostic processes.

2.2 AI in Healthcare Collaboration

The integration of AI in collaborative tools presents opportunities to enhance decision-making and predictive analytics. Bolu (2024) emphasizes the role of big data in self-learning AI systems, which can dynamically adapt and optimize processes based on vast datasets. In healthcare, AI can assist in diagnosing, predicting patient outcomes, and providing evidence-based recommendations, thereby supporting healthcare professionals in their clinical decisions.

Yousuf et al. (2024) highlight the necessity for culturally sensitive AI solutions in healthcare, especially in regions like the Eastern Mediterranean. AI-driven tools must consider diverse cultural and social factors to provide relevant and accurate support to healthcare professionals.

2.3 Real-Time Communication Technologies

Real-time communication technologies, such as WebSockets, enable instantaneous data exchange between users, which is critical for timely decision-making in healthcare. The literature underscores the importance of integrating such technologies into collaboration platforms to facilitate synchronous interactions, reduce response times, and enhance the overall efficiency of healthcare teams.

2.4 Security and Privacy in Healthcare Collaboration Tools

Healthcare collaboration tools must prioritize data security and privacy to comply with regulations like the Health Insurance Portability and Accountability Act (HIPAA). The literature discusses various approaches to secure data transmission and storage, including encryption, role-based access controls, and secure authentication mechanisms. Ensuring compliance is paramount to protect sensitive patient information and maintain trust among healthcare professionals.

2.5 Gaps and Future Directions

Despite advancements, existing tools often lack comprehensive AI integration tailored to healthcare needs and may not fully address the collaborative dynamics specific to medical environments. Future research should focus on developing AI-driven features that support clinical decision-making, predictive analytics, and personalized knowledge sharing, while also ensuring robust security measures and user-friendly interfaces.

III.METHODOLOGY

The proposed system is conceptualized as a comprehensive, real-time collaboration platform tailored for healthcare professionals. This model integrates multiple functional modules to ensure seamless knowledge sharing, efficient query resolution, and real-time communication. The primary focus is on modularity, scalability, and security, underpinned by robust architectural and technological foundations.

3.1 Conceptual Framework

The system operates as an integrated platform with distinct yet interconnected components, facilitating efficient and collaborative workflows in the healthcare domain. Key elements include community-driven collaboration, AI-augmented query resolution, and information dissemination. The system is designed to bring healthcare professionals together into an active and interactive community, offer smart assistance to resolve user queries using the platform's content as a knowledge base, and ensure up-to-date blogs, news, and industry developments are accessible to all users.

3.2 Functional Architecture

The platform is structured around the following core components:

1. **User Management and Security:** Authentication ensures secure access control, protecting sensitive data. Role-based access assigns users specific roles (junior doctors, senior doctors, experts) to define their permissions.
2. **Real-Time Collaboration Module**: This module employs WebSocket-based communication for instantaneous interaction. Features include live discussions, group forums, and activity alerts to enhance engagement.
3. **Content Repository and Indexing**: A dedicated Content Management System (CMS) organizes and indexes blogs and news articles. The repository enables users to easily search and retrieve relevant information.
4. **AI Query Solver:** A lightweight AI model processes natural language queries to deliver precise and relevant responses, sourcing them from indexed content (e.g., blogs and news) curated within the system.

3.3 Workflow Overview

The system workflow is designed to enable a smooth and intuitive user experience. Initially, users authenticate via the login system, and role-based dashboards provide personalized access to features and data. Users then participate in live discussions or seek advice through topic-specific forums. Notifications ensure users remain informed of new content, updates, and responses. Queries are processed using advanced Natural Language Processing (NLP) techniques, and responses are generated by matching the query to the platform's indexed resources. Blogs, articles, and news are dynamically created, categorized, and made available to users, ensuring continuous updates to reflect the latest developments in the healthcare industry.

3.4 Algorithms Used

The following algorithms and methodologies are employed to ensure the efficient functioning of the system:

1. **Natural Language Processing (NLP) Algorithms**: TF-IDF (Term Frequency-Inverse Document Frequency) is used for ranking and retrieving the most relevant content from the indexed repository in response to user queries. Transformer-based models like BERT or DistilBERT are integrated to handle context-aware query resolution.
2. **Recommendation Algorithms**: Content-Based Filtering suggests blogs, articles, and forums to users based on their interactions and query history.
3. **WebSocket Communication Protocols**: WebSocket-based communication protocols are employed for low-latency, real-time communication, ensuring efficient message delivery during live collaboration sessions.
4. **Security Algorithms**: SHA-256 encryption secures sensitive user data and communication, while OAuth 2.0 protocol manages secure authentication and authorization.
5. **Search and Retrieval Algorithms**: Inverted Indexing speeds up search queries by indexing all content stored in the repository. Levenshtein Distance is used for query correction and fuzzy matching.

3.5 Technical Features

The following technologies and frameworks underpin the proposed system:

1. **Real-Time Interactions**: Built using WebSocket protocols to enable low-latency communication.
2. **AI Integration**: The AI model utilizes pre-trained NLP algorithms for contextual understanding, with periodic updates to the model's dataset ensuring improved accuracy over time.
3. Scalable Architecture: Containerized services using Docker allow independent deployment and scaling of modules, while Kubernetes is employed for orchestration and resource management.
4. Enhanced Security: End-to-end encryption safeguards user communication, and adherence to healthcare standards such as HIPAA ensures compliance with data privacy regulations.

3.6 Scalability and Maintenance

To ensure the platform can support increasing workloads, the following practices are integrated:

Modular design allows each component to be independently scaled or modified without impacting the entire system. CI/CD pipelines streamline integration and deployment to ensure rapid updates with minimal disruption. Cloud hosting enables the platform to handle dynamic user loads efficiently.

IV.RESULTS AND DISCUSSION

4.1 Doctor Login and Profile Management

Secure authentication mechanisms are implemented to ensure that only authorized healthcare professionals can access the platform. Each user has a detailed profile that includes their specialization, experience level, and professional credentials.

4.1.1 Community Forum and AI Query Solver

The community forum allows users to post questions, share case studies, and engage in discussions. The AI query solver assists users by providing instant responses to medical queries, drawing from the platform's extensive repository of blogs and news articles.

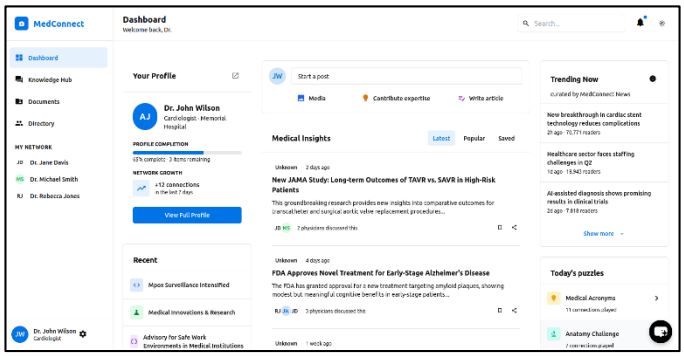

Fig.1. Onboarding Page

4.1.2 News and Blog Section

This section enables users to publish and access the latest news and blog posts related to healthcare.

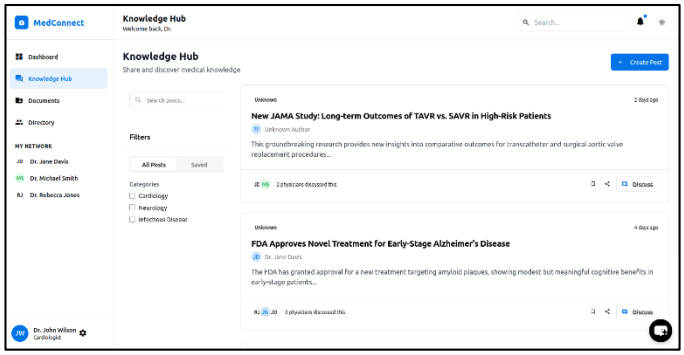

Fig.2. Highlights of the Features

4.1.3 Continuous Integration/Continuous Deployment (CI/CD)

The platform employs CI/CD pipelines to ensure rapid and reliable deployment of updates and new features. This approach minimizes downtime and ensures that users have access to the latest functionalities.

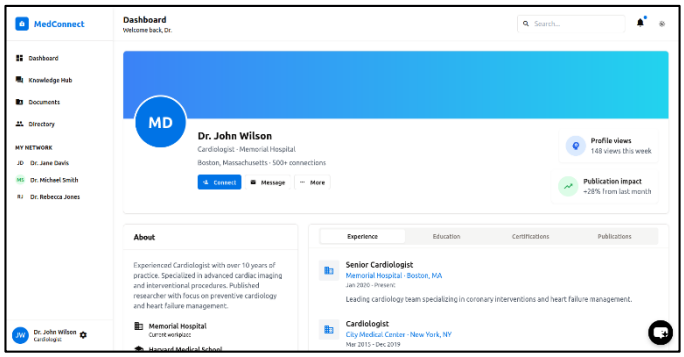

Fig.3. Personal Dashboard and Activity Log

Importance of User Experience (UX) User Experience (UX) plays a pivotal role in the success of healthcare collaboration tools. Healthcare professionals, often working in high-pressure environments, need tools that are intuitive and easy to navigate. Complex or cluttered interfaces can lead to frustration and reduce efficiency, which could negatively impact patient care.

For example, a real-time dashboard displaying patient records, communication threads, and task updates must prioritize clarity. Features like drag-and-drop task assignments or color-coded alerts for emergencies can enhance usability. Designing for speed and simplicity ensures that healthcare workers can focus more on patient care rather than troubleshooting technical issues.

Accessibility is essential in creating inclusive tools that cater to a diverse group of healthcare professionals. Incorporating multi-language support allows professionals from various linguistic backgrounds to collaborate effectively. For instance, an Indian hospital might benefit from a tool that supports regional languages like Hindi, Tamil, or Bengali alongside English.

Voice-activated commands are another valuable feature. Surgeons or nurses who are physically occupied can issue commands or retrieve information hands-free. Additionally, compatibility with screen readers, high-contrast modes for visually impaired users, and large font options can make the platform usable for everyone, including individuals with disabilities.

4.2. AI-Powered Predictive Analytics in Collaboration

Early Detection of Emergencies

AI algorithms can analyze patient data, including heart rates, oxygen levels, and lab reports, to identify early warning signs of medical emergencies. For example, in ICUs, AI-powered platforms can monitor patient vitals continuously and flag abnormalities like sepsis risk or respiratory failure, allowing doctors to act immediately.

Such systems could also send notifications to the entire care team, ensuring that everyone is informed about critical changes in a patient's condition. For instance, if an AI system detects abnormal heart rhythms, it can simultaneously alert the cardiologist, nurse, and the patient's general practitioner for coordinated action.

Predictive analytics can help hospitals optimize resource usage by forecasting patient inflow and staff requirements. During flu season, for example, AI can predict increased admissions based on historical data and notify administrators to prepare additional beds, medications, and personnel.

Moreover, predictive models can prioritize patients based on urgency, ensuring resources are allocated where they are needed the most. For example, an ER system might automatically assign more nurses and doctors to trauma patients while redirecting less critical cases to outpatient facilities.

4.3. Real-Time Collaboration in Rural Healthcare

Bridging the Urban-Rural Divide

Rural healthcare centers often face challenges like limited access to specialists and advanced medical equipment. Real-time collaboration tools can bridge this gap by enabling virtual consultations with urban doctors. For instance, a rural doctor treating a complex pediatric case can connect via video conferencing to a child specialist in an urban hospital for advice.

Platforms like these also support the exchange of medical images, such as X-rays or MRIs, allowing experts to provide insights remotely. This not only improves the quality of care but also reduces the need for patients to travel long distances.

Overcoming Infrastructure Challenges

Rural areas often face connectivity issues, making it essential to design lightweight tools that work effectively in low-bandwidth environments. For example, compressing video streams or offering text-based communication as a fallback option ensures that the platform remains functional despite poor internet connections.

Cloud-based systems with offline capabilities can further enhance usability. Doctors in remote areas can input patient data offline, which syncs automatically when the internet connection is restored.

4.4. Gamification to Encourage Collaboration

Motivation Through Rewards

Gamification can increase engagement by introducing elements of fun and competition into the platform. For example, healthcare professionals might earn points for contributing to forums, solving AI-generated queries, or attending webinars. Accumulating these points can unlock rewards like free access to premium content, certifications, or recognition within the professional community.

Leaderboards can create friendly competition among team members, encouraging them to participate more actively in discussions or collaborative projects. For instance, a hospital might display a leaderboard showing the most active contributors to a case discussion forum, incentivizing others to engage.

Enhancing Team Cohesion

Team-based challenges, like solving hypothetical medical cases or participating in virtual simulations, can strengthen collaboration and knowledge-sharing among professionals. For example, a group of doctors could work together on a simulated surgery case, earning badges or certifications upon successful completion.

These gamified activities not only improve engagement but also foster a sense of community, making the platform more than just a tool—it becomes a learning ecosystem.

4.5. Psychological Impact of Collaboration Tools

Reducing Burnout

Healthcare professionals often experience burnout due to long hours, high-stress situations, and administrative burdens. Collaboration tools that streamline workflows can alleviate this pressure by automating repetitive tasks like scheduling or documentation. For instance, an AI-powered assistant could draft patient summaries based on doctor notes, saving time and effort.

Real-time support from colleagues through forums or quick consultations can also provide emotional reassurance, reducing feelings of isolation.

Improving Job Satisfaction

Efficient tools that foster collaboration and knowledge-sharing can improve job satisfaction by empowering professionals to focus on patient care rather than administrative hassles. Knowing that their insights are valued in forums or case discussions also boosts morale and creates a sense of belonging.

4.6. Integration of Telemedicine with Real-Time Collaboration Tools

Enhancing Remote Patient Consultations

Telemedicine has emerged as a cornerstone of modern healthcare, especially during emergencies like pandemics. Integrating telemedicine capabilities with real-time collaboration tools can revolutionize patient care. For instance, a collaboration tool could allow doctors to seamlessly switch from discussing a case in a forum to a video call with the patient, ensuring continuity and context.

Additionally, such tools can enable multi-specialty consultations in real-time. For example, a general physician diagnosing a complex case could involve a cardiologist, pulmonologist, and dietician simultaneously via a shared telemedicine interface, ensuring holistic treatment planning.

Combining Telemedicine with Wearable Devices

Wearable devices, such as smartwatches or continuous glucose monitors, can provide real-time health data to telemedicine platforms. Collaboration tools can process this data and alert doctors during remote consultations if a patient's vitals show alarming trends. For example, a wearable ECG monitor might detect arrhythmias during a virtual checkup, immediately notifying the doctor and other specialists within the platform.

4.7 Cross-Functional Collaboration in Multidisciplinary Teams

Addressing Complex Cases

Modern healthcare often involves multidisciplinary teams working together to address complex cases, such as cancer treatment or organ transplantation. Collaboration tools can act as a centralized hub where oncologists, radiologists, surgeons, and pathologists share patient data, imaging results, and treatment progress.

For instance, a platform can integrate features like collaborative document annotation, where a radiologist uploads an X-ray image, and the oncologist marks areas of concern directly on the platform, enabling other specialists to view these annotations and provide input.

Encouraging Knowledge Exchange

Incorporating features like cross-functional forums fosters knowledge-sharing between teams working in different specialties. For example, pediatricians and neurologists can discuss overlaps in their fields, such as childhood epilepsy, while sharing case studies and research insights.

4.8. Advanced Data Visualization for Decision-Making

Interactive Dashboards

Collaboration tools can enhance decision-making through interactive dashboards that visualize complex patient data. For instance, a dashboard can display trends in a patient's blood sugar levels, medication history, and lab results in an integrated manner. This visualization allows doctors to spot patterns, such as correlations between a medication's dosage and improvements in health metrics.

Predictive Analytics for Better Insights

AI-powered data visualization tools can predict future trends. For example, based on historical data, a dashboard might alert a cardiologist to a patient's increasing risk of a heart attack, recommending preventive actions like lifestyle changes or additional tests.

Additionally, visualizations like heatmaps and time-series graphs can help hospitals optimize resource allocation, such as identifying peak hours in emergency departments or predicting shortages of essential supplies.

4.9. Emotional Support Networks for Healthcare Workers

Peer-to-Peer Support Forums

Healthcare workers often experience high stress and emotional strain. Collaboration platforms can integrate peer-to-peer support forums where professionals discuss challenges, share coping strategies, and offer encouragement. For example, junior doctors might seek advice from experienced specialists on handling emotionally taxing situations like delivering bad news to patients.

AI-Powered Mental Health Assistants

AI can play a role in supporting the emotional well-being of healthcare workers. A collaboration tool could include AI chatbots trained to identify signs of burnout or anxiety in professionals based on their interactions. These chatbots can suggest personalized coping strategies, recommend mental health resources, or even escalate concerns to human counselors if needed.

4.10. Real-Time Language Translation for Global Collaboration

Breaking Language Barriers

Healthcare professionals often collaborate across borders, necessitating seamless communication despite language differences. Real-time language translation powered by AI can enable doctors to participate in international case discussions or conferences. For instance, a Spanish-speaking doctor could contribute to an English-language forum, with their inputs translated into English in real-time and vice versa.

Medical **Terminology** Accuracy

Translation tools tailored for healthcare must account for the complexity of medical terminology. For example, AI systems should differentiate between generic terms like "heart condition" and specific terms like "ventricular fibrillation." Collaboration tools can leverage medical dictionaries and AI models specialized in healthcare language to ensure accurate translations, minimizing risks of miscommunication.

4.11 Scenario-Based Simulations for Skill Enhancement

Simulating Emergency Situations

Scenario-based simulations integrated into collaboration tools can help professionals prepare for high-stress situations. For example, a platform could simulate a cardiac arrest scenario where team members must make rapid decisions about defibrillation, medication, and patient transfer logistics. Each member's actions could be tracked and evaluated to improve future performance.

Ongoing Training for Medical Advancements

As medical science evolves, healthcare workers need continuous education. Simulation-based training on collaboration platforms can include virtual workshops on new surgical techniques, drug administration protocols, or updated disease management guidelines. For instance, doctors can practice performing robotic surgeries in a virtual operating room before handling real cases..

VII.CONCLUSION

The Real-Time Collaboration Tool for Healthcare presents a comprehensive solution for enhancing communication and collaboration among healthcare professionals. By integrating AI-driven query solving, secure community forums, and up-to-date news sharing, the platform addresses critical gaps in existing tools. The microservices architecture and real-time communication technologies ensure scalability and reliability, essential for modern healthcare environments.

Future work will focus on expanding the AI capabilities to include predictive analytics for emerging healthcare trends, integrating wearable device data for real-time patient monitoring, and enhancing user interface design for improved accessibility. Additionally, ongoing efforts will be made to ensure compliance with evolving healthcare regulations and to incorporate user feedback for continuous improvement.

VIII.REFERENCE

[1] O. A. Ajiva, O. G. Ejike, and A. O. Abhulimen, "Real-Time Collaboration Tool for Healthcare," *Swanta Ventures*, Nigeria, 2023.

[2] A. A. A. Yousuf, D. C. Stewart, T. Kane, A. Soltani, A. Al-Khal, and A. Sethi, "Health Professionals' Views and Experiences of Breaking Bad News in the Eastern Mediterranean Region: A Scoping Review," *Eastern Mediterranean Health Journal*, 2022.

[3] D. Garfrinkel, B. C. Welti, and T. W. Yip, "HP SharedX - Collaboration Tool," *HP Journal*, 1990.

[4] S. S. Leong, J. H. D. Wong, and K. H. Ng, "Ultrasound-Based Elastography: Principles and Clinical Applications," *Clinical Imaging*, 2021.

[5] T. Bolu, "The Role of Big Data in Self-Learning AI Systems," *Journal of Artificial Intelligence Research*, vol. 9, pp. 1–10, 2021.

[6] A. U. R. Butt, T. Mahmood, T. Saba, S. A. O. Bahaj, F. S. Alamri, M. W. Iqbal, and A. R. Khan, "An Optimized Role-Based Access Control Using Trust Mechanism in E-Health Cloud Environment," *IEEE Access*, vol. 9, pp. 76543–76555, 2021.

[7] M. Eshghali, D. Kannan, N. S. Meydani, and A. M. E. Sikaroudi, "Machine Learning Based Integrated Scheduling and Rescheduling for Elective and Emergency Patients in the Operating Theatre," *Computers in Biology and Medicine*, vol. 125, p. 104004, 2020.

[8] R. Kitsiou, G. Pare, and M. Jaana, "Systematic Reviews and Meta-Analyses of Home Telemonitoring Interventions for Patients with Chronic Diseases: A Critical Assessment of Their Methodological Quality," *Journal of Medical Internet Research*, vol. 15, no. 7, p. e150, 2013.

[9] T. W. Malone, *The Future of Work: How the New Order of Business Will Shape Your Organization, Your Management Style and Your Life*, Boston, MA, USA: Harvard Business Review Press, 2004.

[10] J. Esteva, K. A. Robicquet, B. Ramsundar, M. Kuleshov, M. DePristo, and A. L. Beam, "A Guide to Deep Learning in Healthcare," *Nature Medicine*, vol. 25, pp. 24–29, 2019.