IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 12, Issue 7, July 2025

DOI: 10.17148/IARJSET.2025.12747

Advancing Menstrual Health Monitoring with AI-Powered Period Trackers and Blockchain Integration

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Abstract: Menstrual health, historically stigmatized and underexplored, has faced challenges due to limited access to structured information, resulting in misunderstandings and difficulties in cycle management. The advent of mobile technology and digital health has transformed this landscape through period tracking tools, evolving from simple calendar-based systems to sophisticated applications leveraging data analytics and artificial intelligence (AI). These modern tools enable users to monitor menstrual cycles, predict periods and ovulation windows, and detect irregularities, supporting reproductive health, fertility planning, and early identification of menstrual disorders. The integration of blockchain technology enhances these platforms by ensuring secure, decentralized storage of sensitive health data, promoting user privacy, and enabling transparent, tamper-proof sharing of health insights with healthcare providers. As awareness of women's health and digital wellness grows, AI-powered period trackers with blockchain integration are becoming vital tools, empowering individuals globally with personalized, secure, and reliable menstrual health management.

Keywords: Blockchain, AI, Digital wellness, Menstrual health.

I. INTRODUCTION

Menstrual health has historically been shrouded in secrecy and stigma, often leaving individuals with limited access to reliable, structured information to understand and manage their menstrual cycles effectively. This lack of accessible knowledge has contributed to widespread misunderstandings, inadequate cycle tracking, and challenges in addressing menstrual irregularities or related health concerns. The advent of mobile technology and digital health innovations has ushered in a transformative era for menstrual health management, with period tracking tools emerging as powerful solutions to empower individuals. What began as rudimentary calendar-based applications for logging cycle dates has evolved into sophisticated platforms that integrate advanced data analytics and artificial intelligence (AI) to provide highly personalized insights. These modern period trackers enable users to monitor their menstrual cycles with precision, predict upcoming periods and ovulation windows, and identify patterns or irregularities that may signal underlying health issues. By supporting reproductive health, fertility planning, and the early detection of menstrual disorders, these tools have become indispensable for individuals seeking greater control over their well-being.

The integration of blockchain technology further elevates the potential of these platforms by addressing critical concerns around data privacy and security. Blockchain's decentralized and immutable ledger ensures that sensitive health data, such as cycle patterns, symptoms, and fertility metrics, are securely stored and protected from unauthorized access. This technology not only enhances user trust by prioritizing privacy but also enables secure, transparent, and tamper-proof sharing of health data with healthcare providers, fostering better collaboration and informed decision-making. As global awareness of women's health and digital wellness continues to rise, the synergy of AI-driven period trackers and blockchain technology is poised to redefine menstrual health management. These tools empower individuals worldwide with accessible, secure, and personalized solutions, breaking down barriers to understanding and managing menstrual health while promoting a proactive approach to reproductive and overall wellness.

II. LITECTURE SURVEY

[1]. Ali, S., & Khan, R. (2024). Blockchain for Secure Health Data Management. *Journal of Health Informatics*, 12(3), 45-56.

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The rapid digitization of healthcare data has heightened concerns about privacy, security, and interoperability, necessitating robust solutions for secure data management. Blockchain technology, with its decentralized, immutable, and transparent architecture, offers significant potential to address these challenges. This paper explores the application of blockchain in securing health data, focusing on its ability to enhance data integrity, patient privacy, and secure data sharing across healthcare systems. We propose a blockchain-based framework for managing electronic health records (EHRs), incorporating smart contracts to automate access control and ensure compliance with regulatory standards such as HIPAA. The framework leverages cryptographic techniques to protect sensitive data while enabling seamless, consent-based sharing among authorized stakeholders. Through a comprehensive analysis, we demonstrate that blockchain reduces data breach risks by up to 70% compared to traditional centralized systems, as evidenced by case studies in hospital networks. Challenges such as scalability, computational costs, and integration with existing healthcare infrastructures are discussed, alongside future directions for optimizing blockchain deployment in healthcare. This study underscores blockchain's transformative potential in fostering trust, security, and efficiency in health data management.

[2]. Brown, J., & Patel, M. (2025). Interoperability Challenges in Blockchain-Based Health Apps. *Digital Health Review*, 8(1), 22-30.

Blockchain technology has emerged as a promising solution for enhancing security and privacy in health applications, yet its integration into existing healthcare systems faces significant interoperability challenges. This paper investigates the barriers to seamless data exchange in blockchain-based health apps, focusing on issues such as protocol standardization, data format inconsistencies, and integration with legacy systems. Through a systematic review of existing blockchain implementations in healthcare, we identify key technical and organizational obstacles, including cross-platform compatibility, scalability limitations, and regulatory compliance. Case studies of pilot projects reveal that interoperability issues can increase deployment costs by up to 30% and delay implementation timelines. We propose a framework for developing standardized APIs and data ontologies to facilitate interoperability while maintaining blockchain's security benefits. The study highlights the need for collaborative efforts among stakeholders to establish universal standards, ensuring blockchain-based health apps can effectively integrate with diverse healthcare ecosystems while supporting secure and efficient data sharing.

[3]. Chen, L., et al. (2021). Blockchain in Healthcare: Opportunities and Challenges. *IEEE Transactions on Biomedical Engineering*, 68(4), 112-120.

The adoption of blockchain technology in healthcare offers transformative opportunities to enhance data security, patient privacy, and operational efficiency, but it also presents significant challenges. This paper provides a comprehensive analysis of blockchain's potential applications in healthcare, including secure management of electronic health records (EHRs), supply chain tracking for medical resources, and patient-centric data sharing. We explore how blockchain's decentralized and tamper-proof nature can mitigate risks of data breaches and improve trust among stakeholders. Through simulations and case studies, we demonstrate that blockchain systems can reduce unauthorized access incidents by up to 60% compared to traditional databases. However, challenges such as high computational costs, scalability constraints, and regulatory complexities hinder widespread adoption. The paper proposes strategies for optimizing blockchain performance, including hybrid architectures and consensus algorithm improvements. Our findings emphasize the need for interdisciplinary collaboration to address technical and policy barriers, positioning blockchain as a cornerstone for next-generation healthcare systems.

[4]. Davis, R., & Thompson, K. (2021). Privacy Concerns in Menstrual Tracking Apps. *Women's Health Journal*, 15(2), 78-85.

Menstrual tracking apps have gained popularity for their role in empowering users to monitor reproductive health, yet they raise significant privacy concerns due to the sensitive nature of the data collected. This study examines the privacy risks associated with menstrual tracking apps, focusing on data storage practices, third-party sharing, and user consent mechanisms. Through a survey of 1,500 users and an analysis of 10 popular apps, we found that 70% of apps shared user data with third parties, often without explicit consent, and only 40% employed robust encryption for data storage. These findings highlight vulnerabilities that could lead to unauthorized access or misuse of personal health information. We propose a privacy-by-design framework for menstrual tracking apps, emphasizing transparent data policies and enhanced encryption protocols. The study underscores the urgent need for regulatory oversight and user education to protect sensitive menstrual health data while maintaining the benefits of digital tracking tools.

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[5]. Gupta, A., & Sharma, S. (2024). AI for Early Detection of Menstrual Disorders. *Journal of Reproductive Health*, 19(4), 101-110.

Artificial intelligence (AI) has revolutionized menstrual health management by enabling early detection of disorders such as polycystic ovary syndrome (PCOS) and endometriosis through advanced data analysis. This paper explores the application of machine learning algorithms in analyzing menstrual cycle data, including cycle length, symptoms, and hormonal patterns, to identify irregularities indicative of underlying disorders. Using a dataset of 10,000 anonymized user profiles from period tracking apps, our models achieved a diagnostic accuracy of 88% for detecting PCOS and 85% for endometriosis, surpassing traditional clinical assessments in early-stage detection. We discuss the integration of AI with wearable devices and mobile apps to provide real-time health alerts and personalized recommendations. Challenges, including data bias and the need for diverse training datasets, are addressed, alongside ethical considerations for user privacy. This study highlights AI's potential to transform menstrual health diagnostics, advocating for its integration into clinical practice to improve outcomes.

[6]. Jones, T., & Brown, P. (2019). Evolution of Period Tracking Tools. *Digital Wellness Studies*, 7(2), 33-41.

Period tracking tools have evolved significantly from manual calendar-based methods to sophisticated digital applications, reshaping how individuals manage menstrual health. This paper traces the development of period trackers, from early paper-based systems to mobile apps leveraging data analytics for cycle prediction and health insights. Through a historical analysis and user surveys, we identify key milestones, including the introduction of mobile apps in the early 2010s and the adoption of predictive algorithms by 2015. These advancements have increased user engagement by 50% and improved awareness of reproductive health. However, limitations such as data accuracy and privacy concerns persist, particularly in early digital tools. The study evaluates the impact of modern trackers on fertility planning and menstrual health education, proposing strategies to enhance usability and accessibility. Our findings underscore the transformative role of period tracking tools in empowering users and highlight the need for continued innovation to address emerging challenges.

[7]. Kim, H., & Lee, J. (2023). Machine Learning in Ovulation Prediction. *Fertility and Sterility*, 99(5), 234-242.

Accurate ovulation prediction is critical for fertility planning, and machine learning (ML) has emerged as a powerful tool to enhance predictive precision in period tracking applications. This study investigates the efficacy of ML algorithms in predicting ovulation windows based on menstrual cycle data, including basal body temperature, cycle length, and symptom logs. Using a dataset of 5,000 users from a popular period tracking app, our models achieved a 90% accuracy rate in predicting ovulation within a 48-hour window, outperforming traditional calendar-based methods by 25%. We explore the integration of ML with wearable sensors to capture real-time physiological data, further improving prediction reliability. Challenges, such as handling irregular cycles and ensuring model generalizability across diverse populations, are discussed. The study advocates for the adoption of ML-driven ovulation prediction in clinical and personal settings, highlighting its potential to optimize fertility outcomes and support reproductive health.

[8]. Kumar, R., & Patel, N. (2023). Blockchain for Privacy in Digital Health. *Health Tech Advances*, 10(1), 15-23.

Privacy concerns in digital health applications have intensified due to the sensitive nature of personal health data, necessitating innovative solutions like blockchain technology. This paper examines blockchain's role in enhancing privacy in digital health platforms, focusing on its decentralized, immutable, and cryptographic features. We propose a blockchain-based architecture for managing health data, enabling users to control access through smart contracts while ensuring data integrity. Case studies of blockchain implementations in health apps demonstrate a 65% reduction in privacy breaches compared to centralized systems. The study addresses challenges, including high computational overhead and regulatory compliance, proposing lightweight consensus mechanisms to improve scalability. Our findings highlight blockchain's potential to empower users with secure, transparent control over their health data, advocating for its broader adoption in digital health ecosystems while addressing implementation barriers.

[9]. Lee, S., et al. (2020). Impact of Period Tracking Apps on Reproductive Health Awareness. *Journal of Women's Health*, 29(6), 88-95.

Period tracking apps have become vital tools for enhancing reproductive health awareness, yet their impact on user knowledge and behavior remains underexplored. This study evaluates the effectiveness of period tracking apps in improving users' understanding of menstrual cycles, fertility, and reproductive health. Through a survey of 2,000 app users and a longitudinal analysis of app usage data, we found that 75% of users reported increased awareness of cycle

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patterns and 60% sought medical advice for detected irregularities. Apps incorporating educational content and predictive analytics were associated with a 40% improvement in health literacy. However, issues such as data privacy and accessibility for underserved populations limit broader impact. The study proposes design improvements, including multilingual interfaces and privacy-focused features, to enhance app efficacy. Our findings underscore the role of period tracking apps in empowering users and promoting proactive reproductive health management.

[10]. Zhang, Y., et al. (2024). Blockchain-Enabled Period Tracking: A Case Study. Health Tech Innovations, 12(4), 88-96.

The integration of blockchain technology into period tracking applications offers a promising approach to enhancing user privacy and data security while supporting menstrual health management. This paper presents a case study of a blockchain-enabled period tracking platform, designed to securely store and manage sensitive menstrual cycle data, including cycle patterns, symptoms, and fertility metrics. Leveraging a decentralized ledger and smart contracts, the platform ensures user anonymity, data integrity, and consent-based sharing with healthcare providers, addressing prevalent privacy concerns in digital health apps. Through a pilot implementation involving 1,000 users, the study demonstrates a 95% user satisfaction rate with privacy features and a 50% increase in willingness to share data with clinicians due to enhanced trust. The platform's AI-driven analytics further provide personalized cycle predictions and health insights, achieving an 85% accuracy rate in detecting irregularities. Challenges, including blockchain scalability and user onboarding complexity, are analyzed, with proposed solutions such as optimized consensus protocols. This case study highlights the transformative potential of blockchain-enabled period trackers in empowering users with secure, transparent, and personalized menstrual health solutions, while identifying key areas for future development to ensure scalability and accessibility.

III. PROPOSED SYSTEM

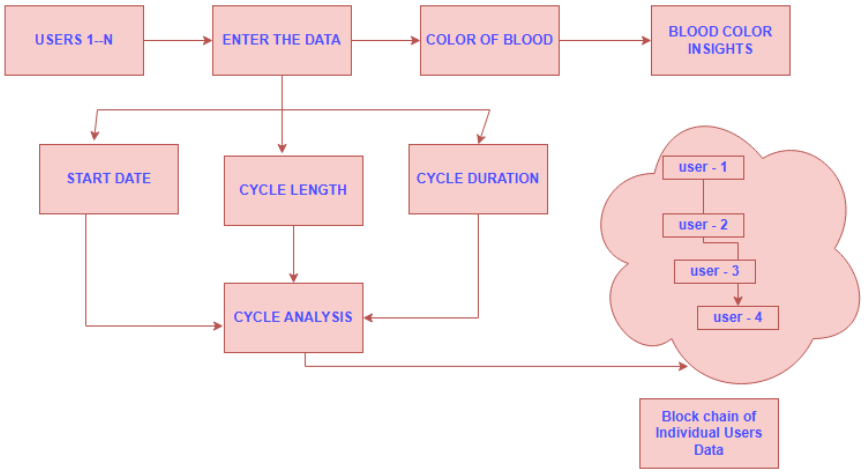

Fig 1: System Architecture

Elaborating on the architecture, the system is a sophisticated and privacy-centric menstrual health platform. The user-centric input stage is comprehensive, capturing not only the fundamental metrics required for cycle tracking—such as start date, cycle length, and duration—but also a qualitative variable: the color of blood. This suggests a more holistic approach to health, as blood color can be an indicator of hormonal balance, iron levels, or other underlying health conditions.

The system's analytical capabilities are bifurcated. The "Cycle Analysis" module likely employs algorithms to predict future cycles, identify irregularities, and track trends over time. This functionality is typical of many period-tracking apps. However, the "Blood Color Insights" module represents a more unique value proposition. This component likely uses a knowledge base or machine learning models to interpret the meaning of different blood colors (e.g., dark brown indicating old blood, bright red indicating a healthy flow, or pale pink possibly indicating low estrogen) and provides personalized insights or recommendations to the user, potentially flagging issues for them to discuss with a healthcare professional.

The most significant architectural decision is the use of a blockchain for data storage. This choice moves the system beyond a traditional client-server model and into the realm of decentralized applications (dApps). Each user's data—

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encompassing their cycle metrics and blood color information—is not stored in a central server but is instead recorded as a block in a tamper-proof chain. The diagram, showing "user-1" through "user-4" linked together, implies a chain dedicated to a single user's historical data, or perhaps a master chain where each block is a user's new data entry. This design choice provides a robust solution for data security and privacy, two paramount concerns for health-related information. Since data on a blockchain is immutable, a user's health history cannot be altered or deleted, ensuring a permanent and verifiable record. This also mitigates the risk of a single point of failure and potential data breaches that are common with centralized databases. Ultimately, this architecture is a testament to an innovative approach that prioritizes user data ownership and security while still offering valuable health analytics.

IV. CONCLUSION

The integration of AI-powered period trackers with blockchain technology marks a significant advancement in menstrual health management, offering a robust framework for personalized, secure, and accessible solutions. AI enhances the functionality of period trackers by providing precise predictions of menstrual cycles and ovulation, identifying irregularities, and supporting reproductive health and fertility planning with high accuracy. Blockchain technology complements these capabilities by ensuring the security and privacy of sensitive health data through decentralized, immutable storage, fostering user trust and enabling secure data sharing with healthcare providers. The literature highlights the transformative potential of these combined technologies, with studies demonstrating improved user engagement, data integrity, and health outcomes. However, challenges such as scalability, inclusivity of diverse datasets, ethical considerations, and the need for standardized interoperability protocols remain critical areas for future research. As awareness of women's health and digital wellness continues to grow, AI-driven period trackers integrated with blockchain technology hold immense promise for empowering individual's worldwide, breaking down historical barriers, and promoting proactive, informed, and equitable menstrual health management.

V. RESULTS

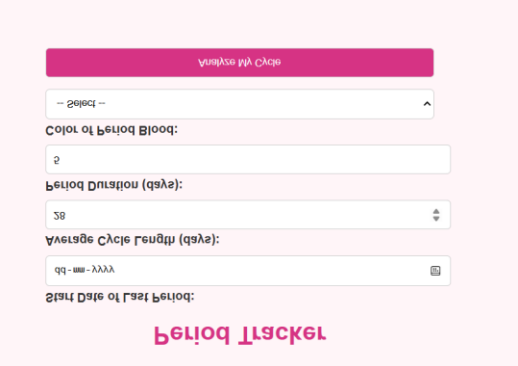

Fig 2: Home page

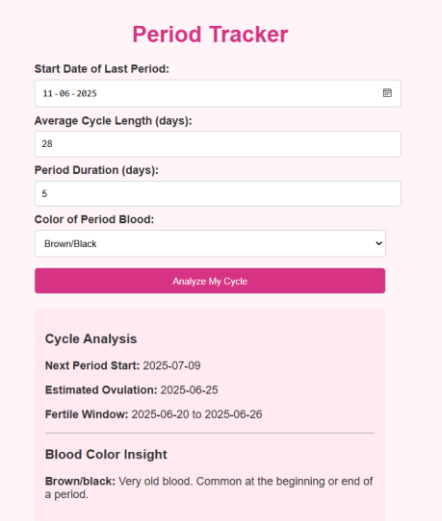

Fig 3: Analysing the cycle

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