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A Review on Human Lung Medical Image Analysis Using Blockchain Technology

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A B S T R A C T

Blockchain technology has drawn interest as a potential remedy for issues with data security, privacy, and trust in healthcare when it comes to medical image processing, especially for lung imaging. Blockchain offers a decentralised, unchangeable ledger system that can safely store and exchange medical pictures, improving patient privacy, facilitating improved provider collaboration, and guaranteeing data integrity. The use of blockchain in lung medical image processing is examined in this review study, along with its potential benefits, applications, and issues that need to be resolved. The review also presents a detailed literature review with a comparative analysis of existing methods.

Keywords: blockchain, decentralized, immutableledger, healthcare, medical images

1. Introduction

Lung medical image analysis plays a crucial role in the diagnosis and monitoring of diseases such as lung cancer, tuberculosis, pneumonia, and chronic obstructive pulmonary disease (COPD). Medical imaging techniques, including X-rays, CT scans, and MRIs, provide detailed insights into lung conditions, helping clinicians make accurate diagnoses[1]. Howeverthere are several challenges associated with the handling, storage, and sharing of medical images, including data security, privacy, and authenticity. These challenges become particularly relevant when dealing with large-scale image datasets[2].

Blockchain technology, known for its secure and decentralized nature, is gaining traction as a potential solution to these challenges[3]. By leveraging blockchain's distributed ledger system, medical image data can be securely stored, tracked, and shared across multiple entities without compromising privacy or data integrity[4]. This review aims to explore how blockchain can enhance lung medical image analysis, provide a comprehensive literature review, and discuss its applications, advantages, and limitations.

1.1 Blockchain Technology Overview

Blockchain is a distributed ledger technology that records transactions across multiple computers in a way that ensures the security, transparency, and integrity of data[5]. Each record, called a "block" contains data and is linked to the previous block, forming a chain[6]. Once a block is added to the blockchain, it is virtually immutable, meaning that it cannot be altered without changing all subsequent blocks, a feature that ensures the security and integrity of stored data[7]. In healthcare, blockchain can be used to store medical images, patient records, and other sensitive health information[8]. Blockchain's decentralized nature eliminates the need for a central authority, allowing multiple parties to access and share data securely[9].

1.2 Key Characteristics of Blockchain in Healthcare

- Decentralization: No single entity has control over the system.
- Immutability: Once data is added to the blockchain, it cannot be modified, ensuring data integrity.
- Transparency: Blockchain allows authorized users to view the entire history of the data.
- Security: Cryptographic techniques safeguard data from unauthorized access or tampering.

Fig 1 illustrates the Elliptic Curve Digital Signature Algorithm (ECDSA). It is used to create digital signatures for a number of purposes, including cryptocurrency like Ethereum and Bitcoin. Every Bitcoin address is generated by cryptography hashing an ECDSA public key. The actual owner of the account is whoever has access to the ECDSA private key. The foundation of ECDSA is Elliptic Curve Cryptography (ECC). A mathematical equation of the form y^2 = x^3 + ax + b, where a and b are constants, defines an elliptic curve. It creates a digital signature for a particular message that other users with access to the signer's public key can validate a potent cryptographic algorithm that produces safe and effective digital signatures by utilizing the benefits of elliptic curve cryptography.

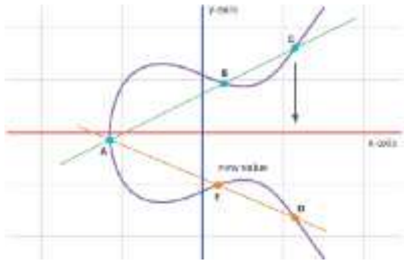

Fig 1: Elliptic Curve Cryptography

ECDSA is now a vital part of contemporary cryptography, helping to secure digital transactions and communications thanks to its strong security and extensive range of uses. Finally, Certificate Authorities (CAs) sign digital certificates using ECDSA as well.

2. Related Review

The present review examines a variety of papers from reputable publications and journals. For this survey, research and review articles based on blockchain and health care technologies were consulted.

According to Haleem et al. (2021), Blockchain is a decentralized digital ledger that records transactions on multiple computers, ensuring secure and transparent data management.The integration of Blockchain technology, machine learning, and 3D scanning in healthcare and other industries presents exciting opportunities for innovation and improvement, enhance data security, and deliver better outcomes for patients and consumers.

Namasudra et al. (2021) discuss the state-of-the-art and research challenges in blockchain technology, highlighting the importance of blocks being linked to each other in a chain. The authors emphasize the use of assurance mechanisms to ensure the integrity of the blockchain.

Srinivasulu et al., (2021) proposed a method that utilizes an extended Convolutional Neural Network (CNN) for predicting lung cancer based on blockchain material. This approach aims to improve the accuracy of lung cancer prediction by leveraging the benefits of blockchain technology. The study highlights the potential of combining blockchain and CNN for early-stage lung cancer diagnosis.

Bazel et al., (2021) explored the integration of blockchain technology in healthcare systems, highlighting its ability to manage big data in a decentralized, secure, and transparent manner. It discusses the benefits of blockchain, such as ensuring immutability and tamper-proof health data storage, and how it can optimize healthcare data management.

Geo et al., (2022) provided a comprehensive survey of blockchain technology, covering its overview, consensus algorithms, smart contracts, and cryptography. It explores various blockchain applications, including cryptocurrencies, supply chains, and the Smart Dubai Office. Then discusses security measures related to security analysis, detecting malicious codes, and privacy preservation. It also compares eleven smart contract bytecode vulnerability analysis tools. Overall, the paper highlights blockchain's broad applications and its security concerns.

Aboamer et al., (2022) analyzed how factors like the number of epochs, images, pixels, features, and padding impact CNN accuracy in lung cancer prediction and food safety analysis. Image augmentation improved accuracy when features and filters were correctly applied, but overfitting reduced accuracy.

Pawar et al., (2022)proposed two architectures—VGG-16 and U-Net—for lung nodule prediction and malignancy level detection using lung scan images. The integration of the Internet of Things (IoT) helps in identifying and classifying lung cancer at different stages, enabling early diagnosis and more accurate results. This method reduces false positives during the early identification stages, achieving higher accuracy, speed, and efficiency compared to current techniques.

Rajasekaran et al., (2022) provided a comprehensive survey of blockchain technology, explaining how it fosters trust between anonymous users for secure transactions without third-party intermediaries. It details the structure of blockchain, including the roles of nodes, miners, and blocks. The transaction process and the blockchain consensus mechanism are also thoroughly discussed.

Smith et al., (2022) offered a thorough review of emerging blockchain-based healthcare technologies and their applications. It highlights key open research issues in the rapidly evolving field and explores the potential of blockchain to transform the healthcare industry.

Chillapalliet. al., (2023)conducted a review of diagnostic strategies for predicting pulmonary embolism (PE) in Computed Tomography Pulmonary Angiograms (CTPA). It provides detailed images of the pulmonary vasculature.Furthermore, studies have explored the accuracy of using d-dimer/fibrinogen ratios to predict PE, with diagnostic strategies including d-dimer testing, clinical pretest probability assessment.

Lakhan et al., (2023) presented the Blockchain Internet of Medical Things (BIoMT) architecture for secure lung cancer workflow data fusion in fog cloud networks. It introduces the Blockchain Data Fusion Secure (BDFS) algorithm, which includes task scheduling and blockchain validation. The goal is to minimize task makespan while ensuring security and meeting deadline constraints. The architecture offers an efficient, secure solution, advancing digital healthcare systems for lung cancer data processing.

Shinde et al., (2024) highlighted the role of Blockchain technology in securing AI-based healthcare applications against various attacks. It acknowledges the challenges posed by the healthcare sector's regulatory constraints, slow adoption of new technologies, and lack of standardized IT infrastructure. Blockchain is identified as a potent solution to these issues. Future research may focus on developing lightweight Blockchain solutions tailored to AI healthcare applications, promising enhanced security and resilience.

Kalidindi et al., (2024)conducted a study on secured data sharing for lung cancer detection using blockchain technology.The research focused on the use of deep learning algorithms for lung cancer detection on chest X-rays.The study contributes to the advancement of technology in healthcare by utilizing blockchain for secure data sharing in lung cancer detection.

Gupta et al., (2024) introduced a framework combinedBlockchain technology and Federated Learning (FL) to enable collaborative model training while preserving patient data privacy.Blockchain authenticates patient data, and FL facilitates on-device learning. The DenseNet-201 model is used for lung disease classification, with parameter aggregation via the FedAvg algorithm and blockchain storage via IPFS. The framework, tested with Python and libraries like TensorFlow and Scikit-Learn, achieves high accuracy in lung disease detection.Table 1 illustrates some of the existing applications using blockchain technology.

Table 1. Existing applications of blockchain

Sl.No	Authors & Year	Blockchain Model	Application Area	Key Findings
1	Haleem et al.2021	Decentralised Ledger	Healthcare	ensuring data integrity and preventing tampering.
2	Bazel et al 2021	distributed ledger	Healthcare	tamper-proof health data storage
3	Aboamer. et al. 2022	Blockchain	Image Security	improve the accuracy in lung cancer prediction and food safety determination
4	Lakhan. et al. 2023	Smart Contracts	AI-based Diagnosis	minimize task makespan
5	Kalidindi et al 2024	Blockchain	Lung Cancer detection	secured data sharing for lung cancer detection

3. Architecture of blockchain

The structure of blockchain technology is represented by a list of blocks with transactions in a particular order. These lists can be stored as a flat file or in the form of a simple database. Header is used to identify the particular block in the entire blockchain. Three sets of block metadata are contained in the block header. Previous Block Address/ Hash is a reference to the hash of the previous (parent) block in the chain. The Timestamp is a string of characters that uniquely identifies the document or event and indicates when it was created. A Nonce number which uses only once. The nonce usually starts from zero and is incremented every time the hash is generated until a hash beginning with three zeros is found. Merkel Root is a type of data structure frame of different blocks of data. Fig 2 shows the architecture of blockchain technology.

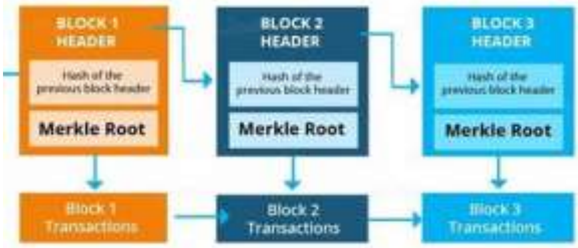

Fig 2: Blockchain Architecture

Blockchain employs digital signatures;The signature in each transaction contains 256 bits. With these characteristics, blockchain has the potential to provide a safe workplace environment soon. A block is made up of every page in a ledger of transactions. The next block is affected by this one due to cryptographic hashing. To update the transaction in the blockchain, an agreement must be reached on the blockchain each time a transaction flag is raised.

Full node and lightweight node are the two important concepts in blockchain technology. The important functionality in the blockchain is carried out by full node. The entire history of the blockchain is stored in the full node.

3.1 Layers of blockchain

Blockchains do not have a single controlling body, all transactions must be safe, and data must be securely maintained on a distributed ledger. The distributed ledger technology (DLT) follows a predetermined protocol, with multiple computers (or nodes) throughout the network coming to a "consensus" to confirm transactional data. To allow this unique kind of transaction authentication, Blockchains feature a layered design. Application Layer includes the smart contracts, decentralized applications (dApps), and other software that run on top of the blockchain network. It enables developers to build new applications and services that leverage the blockchain's security and transparency.

Consensus Layer ensures that all nodes in the network agree on the validity of each transaction. It relies on a consensus mechanism, such as Proof of Work (PoW) or Proof of Stake (PoS), to validate transactions and add them to the blockchain. Network Layer includes the physical network of computers and nodes that communicate with each other to form the blockchain network.

Data Layer stores all transaction data in a secure and immutable manner which contains all the transactions in the blockchain, and the state database, which stores the current state of the blockchain. Hardware Layer includes the physical devices, such as computers and servers that support the blockchain network. Fig 4 shows the layers of blockchain technology.

Fig 4: Layers of Blockchain

4. Applications of blockchain in lung medical image

4.1 Secure Image Storage and Sharing

Blockchain can be used to securely store and share lung medical images. Using decentralized storage systems (such as IPFS - InterPlanetary File System) combined with blockchain, medical institutions can share imaging data without the risk of unauthorized access or tampering. Blockchain provides a transparent, tamper-proof record of who accessed the data, when, and for what purpose.

4.2 Medical Image Authentication and Integrity

Blockchain ensures that lung medical images remain unaltered. Each image is hashed, and the hash is stored in a blockchain. If an image is modified, its hash will change, alerting stakeholders that the image has been tampered with. This feature is particularly important in situations where the accuracy and authenticity of images are crucial for diagnosis and treatment planning.

4.3 AI Model Training and Data Provenance

When using machine learning and AI algorithms to analyze lung medical images, blockchain can be used to trace the data provenance. This means every image used for training AI models can be tracked, ensuring the dataset's integrity and origin. This is crucial in ensuring that AI models are trained on high-quality, authentic data, avoiding biases or errors.

4.4 Patient Data Ownership and Consent Management

Blockchain can facilitate patient-centered control over medical image data. With smart contracts, patients can give or revoke consent for their lung images to be shared or used for research purposes. This ensures that patient autonomy is maintained and that data is only shared with authorized parties.

5. Advantages of blockchain in lung medical image analysis

5.1 Enhanced Data Security

Blockchain's cryptographic features, such as encryption and hashing, provide strong security for medical images. This reduces the risks of unauthorized access, data breaches, and tampering, which are critical concerns in the healthcare industry.

5.2 Improved Transparency and Traceability

Blockchain ensures that every action performed on medical images, such as sharing, modifying, or accessing, is logged and traceable. This feature provides greater transparency and accountability, enabling better audit trails and reducing fraudulent activities.

5.3 Better Collaboration and Interoperability

With blockchain, healthcare providers can collaborate on lung disease diagnosis and treatment without the need for a central authority or intermediary. The decentralized nature of blockchain promotes interoperability between different systems and institutions, facilitating the seamless exchange of medical image data.

5.4 Efficient Data Sharing and Access Control

Blockchain enables efficient, secure, and transparent sharing of lung medical images across different healthcare providers. Smart contracts can be used to define access rules and patient consent, ensuring that only authorized individuals can view or modify the images.

6. Challenges of blockchain

6.1 Scalability Issues

One of the major limitations of blockchain technology is scalability. As the number of transactions (in this case, medical image data) increases, the blockchain can become slower and less efficient. This is particularly relevant for large hospitals or imaging centers dealing with millions of medical images.

6.2 High Computational and Storage Costs

Blockchain requires significant computational resources and energy, especially when used in large-scale systems. The storage of large medical image files on the blockchain can also be expensive, especially if the blockchain is not integrated with efficient decentralized storage solutions.

6.3 Regulatory and Legal Concerns

The integration of blockchain in healthcare faces regulatory and legal hurdles, including concerns over data privacy laws (such as HIPAA in the U.S.) and the potential conflict between blockchain's immutable nature and the right to delete personal data under certain regulations.

6.4 Lack of Standardization

The lack of standardization in blockchain protocols and healthcare data formats can hinder the widespread adoption of blockchain for lung medical image analysis. Interoperability between different blockchain platforms and healthcare systems is a major challenge that needs to be addressed.

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7. Analysis of blockchain in lung medical image

Analyzing blockchain technology's salient characteristics, advantages, difficulties, and possible uses is part of its analysis. Strong security is offered via its cryptographic algorithms, which guard against manipulation and unwanted access. Blockchain technology has enormous promise for use in a variety of industries, including voting systems, supply chain management, healthcare, and finance. Blockchain technology is expected to have a revolutionary impact on a number of businesses as well as society at large as new and creative solutions for data management and secure digital transactions continue to emerge.

7.1 Pros

- Security: It uses decentralized consensus methods and cryptography to provide high levels of security.
- Transparency: A blockchain's recorded transactions offer a clear audit trail and improved accountability since they are traceable and transparent.
- Decentralization: Blockchain technology runs on a decentralized network, which lessens the system's dependency on centralized authorities and increases its resilience.
- Efficiency: Automation and smart contracts can minimize middlemen, simplify procedures, and cut transaction costs.
- Data Integrity: Once a transaction is recorded, it cannot be changed backward without unanimous consent due to the immutability of blockchain data.
- Global Accessibility: Blockchain eliminates the need for middlemen like banks or payment processors by enabling peer-to-peer cross-border transactions.

7.2 Cons

- Scalability: Leading slow transaction processing times and high fees during network congestion.
- Energy Consumption: Bitcoin, require significant computational power and energy consumption, raising environmental concerns.
- Regulatory Uncertainty: The regulatory landscape for blockchain and crypto currencies is still evolving, leading to uncertainty and potential regulatory hurdles.
- Privacy Issues: Although blockchain technology offers pseudonymity, the transparency of transactions may give rise to privacy issues, particularly in delicate sectors such as finance or healthcare.
- Complexity: Some organizations may find it difficult to embrace blockchain solutions due to the complexity and need for specialized technical knowledge involved in their development and implementation.

8. Conclusion

Blockchain technology offers substantial potential in revolutionizing the way lung medical images are analyzed, stored, and shared. The decentralization, security, and transparency inherent in blockchain can solve many challenges faced by healthcare institutions, including data integrity, privacy concerns, and collaboration barriers. However, despite its potential, blockchain's adoption in lung medical image analysis faces challenges, including scalability, regulatory compliance, and high costs. Future research should focus on improving blockchain scalability, reducing costs associated with storing medical images, and developing standardized protocols to ensure interoperability between different healthcare systems. With continued advancements in both blockchain technology and its integration with AI.

Future blockchain advances are anticipated to include improvements in governance frameworks, sustainability measures, privacy-enhancing technology, and consensus processes. Furthermore, there is a great deal of promise for developing cooperative solutions to challenging real-world issues when blockchain is combined with cutting-edge technologies like Artificial Intelligence (AI), the Internet of Things (IoT), and quantum computing. In conclusion, industry demand, technology advancements, and legal changes are all driving the rapid evolution of blockchain applications. Blockchain technology is expected to have a revolutionary effect on a wide range of industries in the future, changing business models, boosting security and trust, and opening up new doors for global social and economic advancement. is also the option to include a subheading within the Appendix if you wish.

References

1. Heidari, Arash, DanialJavaheri, Shiva Toumaj, NimaJafariNavimipour, MahsaRezaei, and Mehmet Unal. "A new lung cancer detection method based on the chest CT images using Federated Learning and blockchain systems." *Artificial Intelligence in Medicine* 141 (2023): 102572.
2. Hasselgren, Anton, Katina Kralevska, DaniloGligoroski, Sindre A. Pedersen, and ArildFaxvaag. "Blockchain in healthcare and health sciences—A scoping review." *International Journal of Medical Informatics* 134 (2020): 104040.
3. Namasudra, Suyel, and Ganesh Chandra Deka, eds. *Applications of blockchain in healthcare*. Vol. 83. Singapore: Springer, 2021.
4. Noman, Abdulla All, MustafizurRahaman, TahmidHasanPranto, and Rashedur M. Rahman. "Blockchain for medical collaboration: A federated learning-based approach for multi-class respiratory disease classification." *Healthcare Analytics* 3 (2023): 100135.

5. Xie, Yi, Lin Lu, FeiGao, Shuang-jiang He, Hui-juan Zhao, Ying Fang, Jia-ming Yang, Ying An, Zhe-wei Ye, and Zhe Dong. "Integration of artificial intelligence, blockchain, and wearable technology for chronic disease management: a new paradigm in smart healthcare." *Current Medical Science* 41, no. 6 (2021): 1123-1133.

6. Chattu, Vijay Kumar. "A review of artificial intelligence, big data, and blockchain technology applications in medicine and global health." *Big Data and Cognitive Computing* 5, no. 3 (2021): 41.

7. Kumar, Rajesh, WenYong Wang, Jay Kumar, Ting Yang, Abdullah Khan, Wazir Ali, and Ikram Ali. "An integration of blockchain and AI for secure data sharing and detection of CT images for the hospitals." Computerized Medical Imaging and Graphics 87 (2021): 101812.

8. Belchior R, Vasconcelos A, Guerreiro S, Correia M. “A survey on blockchain interoperability: Past, present, and future trends.” ACM Computing Surveys (CSUR). 2021 Oct 4;54(8):1-41.

9. Hassan Mansur Hussien, SharifahMdYasin, NurIzuraUdzir, MohdIzuan, Hafez Ninggal, “ Blockchain technology in the healthcare industry: Trends and opportunities”, Journal of Industrial Information 22, 100217,2021.

10. Yao W, Ye J, Murimi R and Wang G. “A survey on consortium blockchain consensus mechanisms.” arXiv preprint arXiv:2102.12058. 2021 Aug.

11. Schär F. “Decentralized finance: On blockchain-and smart contract-based financial markets.” FRB of St. Louis Review. 2021 Apr. X.

12. Haleem, Abid, MohdJavaid, Ravi Pratap Singh, Rajiv Suman, and ShanayRab. "Blockchain technology applications in healthcare: An overview." *International Journal of Intelligent Networks* 2 (2021): 130-139.

13. Namasudra, Suyel, Ganesh Chandra Deka, PrashantJohri, Mohammad Hosseinpour, and AmirH. Gandomi. "The revolution of blockchain: State-of-the-art and research challenges." *Archives of Computational Methods in Engineering* 28 (2021): 1497-1515.

14. Srinivasulu, Asadi, K. Ramanjaneyulu, R. Neelaveni, SantoshachandraRaoKaranam, SankararaoMajji, MuthukumaranJothilingam, and TulasiRadhikaPatnala. "Advanced lung cancer prediction based on blockchain material using extended CNN." ApplNanosci 13, no. 1 (2021): 1-13.

15. Bazel, Mahmood A., Fathey Mohammed, and Mazida Ahmed. "Blockchain technology in healthcare big data management: Benefits, applications and challenges." In *2021 1st International Conference on Emerging Smart Technologies and Applications (eSmarTA)*, pp. 1-8. IEEE, 2021.

16. Guo, Huaqun, and Xingjie Yu. "A survey on blockchain technology and its security." *Blockchain: research and applications* 3, no. 2 (2022): 100067.

17. Aboamer, Mohamed Abdelkader, Mohamed YacinSikkandar, Sachin Gupta, Luis Vives, Kapil Joshi, BatyrkhanOmarov, and Sitesh Kumar Singh. "An investigation in analyzing the food quality well-beingfor lung cancer using blockchain through cnn.", Journal of Food Quality 2022.

18. Pawar, A. B., M. A. Jawale, P. William, G. S. Chhabra, Dhananjay S. Rakshe, Sachin K. Korde, and Nikhil Marriwala. "Implementation of blockchain technology using extended CNN for lung cancerprediction." Measurement: Sensors 24 (2022): 100530.

19. Rajasekaran, ArunSekar, Maria Azees, and Fadi Al-Turjman. "A comprehensive survey on blockchain technology." *Sustainable Energy Technologies and Assessments* 52 (2022): 102039.

20. Smith JA, Johnson MR. “Blockchain technology in healthcare:a comprehensive review.”J.Health Inform. 2022;15(3):112-29.

21. Chillapalli, S. Gite, B. Saini, K. Kotecha and S. Alfarhood, "A Review of Diagnostic Strategies for Pulmonary Embolism Prediction in Computed Tomography Pulmonary Angiograms," in *IEEE Access*, vol. 11, pp. 117698-117713, 2023, doi: 10.1109/ACCESS.2023.3319558.

22. Lakhan, Abdullah, Mazin Abed Mohammed, KarrarHameedAbdulkareem, MohdkhanapiAbdGhani, HaydarAbdulameerMarhoon, Jan Nedoma, RadekMartinek, and Begonya Garcia-Zapirain. "Secure blockchain assisted Internet of Medical Things architecture for data fusion enabled cancer workflow." *Internet of Things* 24 (2023): 100928.

23. Shinde, Rucha, ShrutiPatil, KetanKotecha, VidyasagarPotdar, GaneshsreeSelvachandran, and Ajith Abraham. "Securing AI-based healthcare systems using blockchain technology: A state-of-the-art systematic literature review and future research directions." *Transactions on Emerging Telecommunications Technologies* 35, no. 1 (2024): e4884.

24. Kalidindi, Hari Krishna, and N. Srinivasu. "A Comprehensive Study and Research Perception towards Secured Data Sharing for Lung Cancer Detection with Blockchain Technology." *Annals of Data Science* (2024): 1-41.

25. Gupta, Mansi, Mohit Kumar, and Yash Gupta. "A blockchain-empowered federated learning-based framework for data privacy in lung disease detection system." *Computers in Human Behavior* 158 (2024): 108302.