Blockchain for Pet Welfare:

A Dual Public-Private Adoption Management Architecture

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Abstract

The ever-increasing amount of companion animal populations, together with animal maltreatment are international problems which require transparent and accountable data management. Current microchip databases are fragmented, centralized, and not interoperable, preventing effective data management. This paper proposes a blockchain-based pet adoption and welfare management system that addresses data integrity and ethical accountability issues that lie in pets' industry. The system uses both public and private blockchain networks, especially Ethereum and Hyperledger Fabric respectively, to balance transparency, security and privacy. It features a user-friendly interface that enables stakeholders to navigate the system and its data with ease. The goal of this project is to design and develop dual-chain architecture and evaluate its functionality, reliability, and usability, for a more secure and trustworthy ecosystem for companion animal welfare management.

1. Introduction

"A dog is man's best friend," a proverb captures the deep emotional and social bonds humans shared with dogs throughout history. For centuries, humans shared lives with dogs, giving a wide range of roles. As Hart and Yamamoto (2016) summarize that these roles range from hunting, herding to military and law enforcement roles, and even being an "important family members" (Albert & Bulcroft, 1988). Despite being "the most popular and beloved companion animals, [at] the same time, a huge number of them (and other pets) are abandoned, neglected, abused and needlessly euthanized every year "(as cited in Prato-Previde et al., 2022). This contradiction calls for innovative approaches that can ensure life-long welfare and traceability of companion animals.

1.1. Problem identification and justification:

Continuously people around the world are becoming pet owners, especially dogs and cats. The World Animal Foundation (2025) approximates that there are 900 million dogs in total, with 470 million of them kept as pets. For cats, roughly 600 million exist with 370 million as pets (World Animal Foundation, 2025). Similarly, NIQ (2016) reported that over half of all households globally keep at least one pet, illuminating the growing human–animal bond, emotional and social value pets bring to human society.

However, there is a darker side to the numbers. An estimated 200 million dogs and an even larger number of cats live as strays all around the world (Mair, 2025 citing WHO). In the U.S. alone, around 5.8 million animals enter shelters and rescues annually, and 607,000 animals were euthanized in 2024 (ASPCA, 2025). This suggests that against the rising pet ownership, many welfare systems struggle to sustain long-term responsibility and be under-resourced for animals.

The most widely adopted identification methods for lost or displaced companion animals are microchip registration. A microchip is a small Radio Frequency Identification (RFID) device implanted in animals, containing a unique identification number. The number is tied to details such as owner's information, vaccinations, and health records in an external database. This strives for rapid and reliable identification to reunite lost pets with their owners (Lord et al., 2009; RFIDHY, 2025).

Microchips are broadly used for animal identification and management, although practical use is often problematic as a microchip only holds a unique identification number and is uninformative without an external database (Lord et al., 2009). Many databases are often privately managed and lack interoperability between organizations (Lord et al., 2009). As a result, shelters often struggle with reuniting pets with owners due to outdated or missing registration data (Lord et al., 2009). Lord et al. (2009) also observed that data may not be fetched when multiple registration systems coexist under different manufacturers or jurisdictions. These inconsistencies, unregistered or outdated microchips combined with incomplete records, curb reunification and tracing against animal mistreatment. Likewise, centralized databases could be misused as they are vulnerable to tampering, limitation or even loss.

1.2. Emerging technologies and reviews

To address these drawbacks, there has been a growing interest in using blockchain technology as a more robust alternative for managing pet identities and welfare. A blockchain network creates a secure, verifiable, and transparent record without relying on a single authority (Tripathi et al., 2023). Smart contracts are the self-executing agreements that run directly on the blockchain and can make tasks such

as pet registration, ownership transfer, and adoption agreement simpler, efficient and accurate (Gururaj et al., 2020; Zhou, 2023).

Emerging research and implementation display the potential of this approach. In the realm of pet healthcare, studies propose the usage of blockchain architectures to bind medical records to on-chain assets like Non-Fungible Tokens (NFTs) and store large artifacts off-chain via Inter Planetary File System (IPFS), with smart contracts enforcing modification permissions for access control, and tamper-resistance in electronic medical records (EMRs) for pets (Tripathi et al., 2023; Pham et al., 2023). These studies argue how decentralized designs can boost retrievability, provenance, and trustworthiness of information compared with traditional conventional systems. Within the adoption and ownership domain, academic work focused on eliminating fraud, reducing data fragmentation, and enhancing traceability. For example, a journal article outlines a blockchain-based trusted adoption and fostering system motivated to replace vulnerable, centralized records with verifiable, auditable transactions in Turkish animal shelters (Ölmez & Karaarslan, 2019). Supplementing this, Zhou (2023) describes a smart contract-based decentralized application featuring lost and found functionality as well as incentives to combat data tampering. Alongside academic research efforts, projects and articles further illustrate blockchain's ensuring aspects. Syedhasnaatabbas (2024) highlights how decentralization could overcome fragmented veterinary and supply-chain data, enabling owners to maintain portable and verifiable records. Also, multiple open-source prototypes such as Ethereum Pet Shop, Adoptify, and PetAdoptionPlatform show the use of Ethereum smart contracts for storing each adoption transaction, illustrating how transfers can create permanent and reliable in practice (ritulbari04, 2025; SKA2302, 2024; upascalin3, 2025).

1.3. Reviews on prior work

Most former works highlight the potential of blockchain with respect to transparency, traceability, and accountability, yet there still are some limitations. The majority of existing system focuses on specific uses, such as adoption tracking, donation transparency, or medical record storage, welfare, or ownership data. Additionally, they rely on public blockchains like Ethereum, which excel at transparency but are not suitable for managing sensitive information, such as veterinary records or user data (GeeksforGeeks, 2021). On the flip side, permissioned framework such as Hyperledger Fabric offer controlled access and greater data privacy but operate within closed networks, reducing transparency (GeeksforGeeks, 2021). Few systems explored combining two frameworks in one architecture. For instance, using a public chain for transparent adoption and lost-and-found system, while reserving a private chain for sensitive data. Very recent implementations focused on demonstrating the blockchain mechanism itself with room for more comprehensive and integrated solutions.

These gaps indicate the need for a fully implemented, user-centered adoption system that integrates both public and private blockchain layers. Such a system enables open and verifiable public records along with safeguard for confidential information through access control, thereby strengthening trust, accountability, and usability across the entire pet-welfare ecosystem.

2. The proposed project

2.1. Aims

Design, implement, and evaluate an end-to-end blockchain-based pet adoption system that enhances data integrity, traceability, and ethical accountability employs the strength of both public and private blockchain frameworks.

2.2. Objectives

- To research existing blockchain-based systems for adoption management and define their strengths and weaknesses.
- Analyze both public and private blockchain methods used in any applications.
- Build a dual-blockchain system that integrates Ethereum and Hyperledger Fabric.
- Design a user-friendly UI/UX front-end that users can intuitively interact with.
- Evaluate functionality, reliability and usability of the system.
- Refine and optimize the project based on the evaluation.

2.3. Methodology

A waterfall model with iterative testing and refinement will be employed to develop throughout the project. The procedure will have sequential stages of requirement analysis, system design, implementation, testing, and evaluation. Each stage will build upon the outcome of the preceding stage, such that the development process is structured and traceable.

2.3.1. Designing

The proposed system implements dual blockchain architecture combining:

- Public Ethereum: For logging pets, ownership transfers, and lost-and-found reports.
- Private Hyperledger Fabric: For managing sensitive welfare and identity data such as with controlled access.

The interaction between two systems will be tested during the research and development stage, aiming to develop an interoperative system.

2.3.2. Implementation

The system will be consistent with three degrees: Front-end user interface, Back end/blockchain layer, and Database.

Each will be implemented using eligible programming languages and frameworks, which are to be finalized.

2.3.3. Testing and evaluation

Testing and evaluation will be carried out on both the functional and performance level. Functional testing will ensure that the system operates flawlessly, while performance testing will assess response times, reliability, and data consistency between the two blockchain networks.

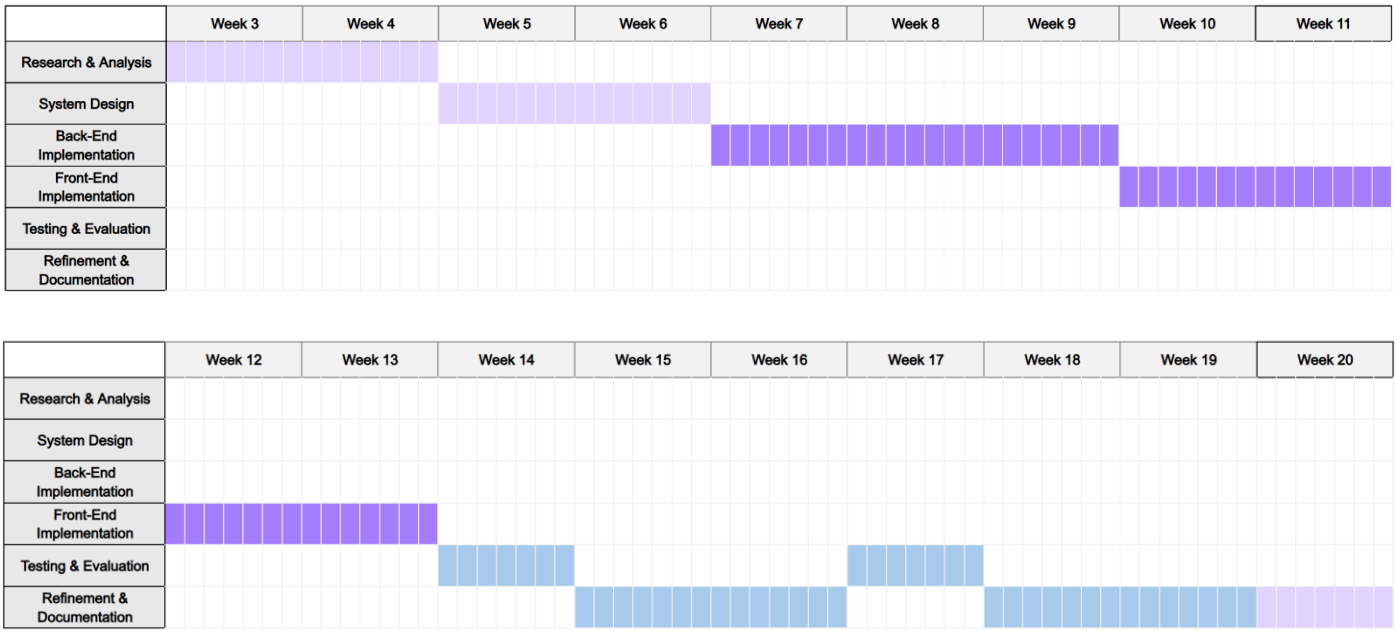
Peer evaluation will also be conducted for user feedback on usability and clarity. All participants will be provided with ethics forms to ensure participants have an understanding of the study and data collection. Testing will be conducted in several cycles for the iterative improvement in the system.

3. Works and plans

The project will commence in week 4 and be submitted in week 20. The following will be the task lists and scheduled timeline:

- Research and analysis: Conduct an in-depth review of existing pet welfare and blockchain-based systems. Define system requirements, functionalities, and data flow.
- System design: Design the system architecture and data model for combining public and private blockchains. Identify smart contracts and private access on the chain.
- Back-end implementation: Develop blockchain system. Also deploy Ethereum and Hyperledger Fabric system along with background system.

- Front-end implementation: Build the web interface for the system while ensuring the smooth and intuitive structure.
- Testing and evaluation: Carry out functional and performance tests for feedback.
- Refinement and documentation: Refine the system based on the feedback and the evaluation. Document the study conducted.



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