

The Library of Things: an Object Lending System for Local Communities

Nicolò Vanzo
Department of Computer Science
University of Turin
Turin, Italy
nicolo.vanzo@unito.it

Emanuele Spadaro
Department of Computer Science
University of Turin
Turin, Italy
emanuele.spadaro@unito.it

Cristina Viano
Department of Computer Science
University of Turin
Turin, Italy
cristina.viano@unito.it

Claudio Schifanella
Department of Computer Science
University of Turin
Turin, Italy
claudio.schifanella@unito.it

Abstract—We propose “The Library of Things”, a blockchain-based lending platform specifically co-designed and implemented for enabling the shared use of tools and objects within local communities. It is based on the CommonsHood platform, a wallet app that allows citizens to create and transfer blockchain-based artifacts represented by cryptographic tokens. The Library of Things has been experimented in different scenarios within communities in the city of Turin.

Index Terms—Tokenization, civic blockchain, local sharing economies, library of things

I. INTRODUCTION

Blockchain technology is increasingly experimented with in the domain of civic participation within local urban communities, but empirical research in this field is still initial. The specific domain we address is local sharing (or collaborative) economies: community-oriented and digitally-enabled sharing systems that take place at the local level, and which are different to business-oriented sharing economies based on global commercial platforms ([1], [2]). We developed a blockchain-based lending platform that allows local communities to implement a Library of Things, which is a community based sharing economy for lending and borrowing unused items. Our goal is to enable a disintermediated booking system, leveraging blockchain technology and tokenization. Other projects experiments with blockchains and digital twins for enabling digital sharing economies [3] [4] [5] [6] [7] or managing traditional libraries [8] and [9]. Our platform is innovative in different ways, which encompass the projects overall social and community goals, the way the library is conceptualized (not relying on a physical places and a centralized bookkeeper) and technical aspects (standard interfaces like ERC20 or ERC721). The application is built as a submodule of CommonsHood, a blockchain-based wallet app that provide citizens with tools to autonomously create and exchange tokens representing (im)material assets which are deemed of relevance for their local economies [10], [11].

II. THE LIBRARY OF THINGS

A. Co-design and concept

The initial design of the Library of Things was based on the requirements of COSO (Italian acronym for Organised Communities for the Exchange of Objects), a project started in March 2023 in a neighborhood of Turin (Italy). COSO participants we active in co-designing, testing ad evaluating the application.

The Library of Things has been co-designed keeping in mind economic, environmental and social goals: allowing people to save money, avoiding waste and consumerism, strengthening community social bonds. In order to ensure a smooth lending and borrowing process in the community, we introduced tokenization, which prioritises: easy loan management by each member of the community; univocal representation of items through NFT as digital twins cite{Huang2020}; reward for positive actions; the importance of physicality and personal encounters in urban spaces; adaptability to different local communities.

B. Functionalities

Each library item is represented by its digital twin, an NFT minted when a user upload the item onto the platform. Other users can send borrowing requests, selecting a start date and an end date. For each day the item is borrowed, the user pays a certain amount of token, depending on the design choice made by the local community. The tokens are sent to the main Library of Things smart contract when a user makes a new request, and to the owner of the item at the end of the lending period. There is also the option of setting up deposits. The loan can have different status: pending, accepted, started, ended. Once the loan has ended, the NFT is transferred back to the lender. Whenever a user completes a good action in his community, (s)he is given a reward in tokens: when s(he) accept community rules for the first time; when s(he) uploads an item; when the loan is finished (tokens are minted

both for the owner and the borrower). The user experience design allow users without any knowledge about blockchain or cryptocurrencies to easily manage the tool.

III. SYSTEM IMPLEMENTATION

The architecture of our system is composed of five smart contracts and a NodeJS microservice. The microservice listens for events emitted from the smart contracts and stores them in a MongoDB database. Clients query this database through an API built using another NodeJS microservice, known as “metadata-dapp”. The key smart contracts are:

- 1) ItemMarketplace.sol: This smart contract is responsible for storing information about the items present in the Library of Things. It allows users to upload new items, transfer an NFT between users, add or remove categories, issue a reward when a user joins the app for the first time, and remove items.
- 2) Calendar.sol: This smart contract handles booking requests. It has functions that manipulate the state of each loan, specifically: created, cancelled, accepted, and ended.
- 3) HashRegistry.sol: This smart contract is responsible for saving and checking the hashes used when a new booking request is sent to the Calendar contract. Only the Calendar smart contract can register a new hash in HashRegistry.
- 4) TokenTemplate.sol: This is an implementation of the ERC20 standard used for the tokens in the system.
- 5) NftTemplate.sol: This smart contract stores the NFT of each item and is an implementation of the ERC721 standard. It transfers the digital twin of an item from the user to the ItemMarketplace smart contract when an item is registered, and transfers it back to the user who has requested the item at the end of the lending period.

IV. TESTING AND EVALUATION

A. UX and UI evaluation

A restricted group of COSO community members took part in the testing phase of the alpha version of the Library of Things. Then the broader community took part in an open testing session. These iterative testing sessions allowed us to identifying the core adjustments needed: adding a communication and messaging system; fine-tuning notifications for guiding the users; searching for objects through filters; managing more complex cases (e.g simultaneous requests for the same object, delayed restitution). Also users that are not familiar with such applications navigated the L’braty’s sections and functionalities without requiring further indications. The application is designed to be adaptable and customizable to the needs of different communities, for instance by setting different values for the tokenized rewards. Its adaptability is being tested with another local sharing economy in Turin (twith he ”CommonsHood in the Garden” project, based on a collective urban garden and on the exchange of gardening tools) and with an educational project where high schools

students co-design and test their own version of the application (the Futurama project in Agrigento and Trapani).

B. Security Evaluation

The security of our smart contracts was evaluated using Slither [12], a static analysis tool. This tool can identify vulnerabilities such as re-entrancy attacks [13], timestamp dependence, insecure arithmetic, and denial of service. The analysis revealed only minor issues, primarily related to variable naming conventions, with no critical bugs detected.

We analyzed potential vulnerabilities in our smart contracts, including timestamp manipulation that could affect time-sensitive operations, and insecure arithmetic practices that could lead to issues like fund misallocation or unexpected behavior.

V. FUTURE RESEARCH

The core functionalities for a decentralized application enabling local community members to borrow unused objects have been successfully developed. Future research will address the adjustments emerged from the participatory evaluation and will further explore the adaptability to local communities that differs in terms of social goals and geographical scope.

ACKNOWLEDGMENT

COSO project is funded by Fondazione Cassa di Risparmio di Torino - Funding programme ”Richieste Ordinarie 2022”.

REFERENCES

- [1] A. Klimczuk, V. Česnūityte, and G. Avram, “The collaborative economy in action: European perspectives,” 2021. [Online]. Available: <https://ssrn.com/abstract=3939152>
- [2] A. Lampinen, A. Light, C. Rossitto, A. Fedosov, C. Bassetti, A. Bernat, P. Travlou, and G. Avram, “Processes of proliferation: Impact beyond scaling in sharing and collaborative economies,” *Proc. ACM Hum.-Comput. Interact.*, vol. 6, no. GROUP, jan 2022. [Online]. Available: <https://doi.org/10.1145/3492860>
- [3] N. García-Moreno, P. Caballero-Gil, C. Caballero-Gil, and J. Molina-Gil, “Building an ethereum-based decentralized vehicle rental system,” vol. 1267 AISC, 2021.
- [4] A. Fedosov, A. Bexheti, E. Ermolaev, and M. Langheinrich, “Sharing physical objects using smart contracts,” 2018.
- [5] S. Huckle, R. Bhattacharya, M. White, and N. Beloff, “Internet of things, blockchain and shared economy applications,” vol. 58, 2016.
- [6] V. P. Ranganathan, R. Dantu, A. Paul, P. Mears, and K. Morozov, “A decentralized marketplace application on the ethereum blockchain,” 2018.
- [7] L. Tiansong and L. Yu, “Design and implementation of second-hand goods renting system based on ethereum smart contract,” 2019.
- [8] J. Cabello, G. Janßen, and A. Mühle, “Distributed library management system based on the blockchain technology. atos it challenge 2017-blockchain executive summary.”
- [9] A. Tella, H. O. Amuda, and Y. A. Ajani, “Relevance of blockchain technology and the management of libraries and archives in the 4ir,” *Digital Library Perspectives*, 2022.
- [10] S. Balbo, G. Boella, P. Busacchi, A. Cordero, L. D. Carne, D. D. Caro, A. Guffanti, M. Mioli, A. Sanino, and C. Schifanella, “Commonhood: A blockchain-based wallet app for local communities,” 2020.
- [11] C. Viano, S. Avanzo, G. Boella, C. Schifanella, and V. Giorgino, “Civic blockchain: Making blockchains accessible for social collaborative economies,” *Journal of Responsible Technology*, vol. 15, 2023.
- [12] J. Feist, G. Grieco, and A. Groce, “Slither: A static analysis framework for smart contracts,” 2019.
- [13] Y. Chinen, N. Yanai, J. P. Cruz, and S. Okamura, “Ra: Hunting for re-entrancy attacks in ethereum smart contracts via static analysis,” 2020.