

## Analysis of Optimization of Digital Archive Systems Through Decentralized Digital Archive Information Systems Based on Irys Datachain

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### Abstract

This research aims to optimize the management of existing digital archives through the development of a decentralized Digital Archive Information System based on Irys Datachain, overcoming the limitations of centralized systems such as vulnerability to cyber attacks, Single Point of Failure, and inefficient access. The long-term goal of this research is to build a sustainable framework that improves data security, archive integration, information availability, and operational cost efficiency through the Irys Datachain decentralized infrastructure. The research method uses a Design Science Research (DSR) approach consisting of three main stages. First, needs analysis to identify operational and system challenges. Second, system development by designing an information system integrated with Irys Datachain as a decentralized storage layer, equipped with Smart Contracts for dynamic access control and transparent audit trails. Third, validation and evaluation of the information system's performance. With the integration of Irys Datachain, this research contributes to innovation in decentralized, transparent, and cost-effective digital archive management that is adaptable to the needs of modern organizations, while strengthening trust in the authenticity and long-term availability of digital archives.

Keywords: digital\_archives; irys\_datachain; design\_science research; smart\_contract

### 1. Introduction

According to experts, archives refer to collections of documents and information that are preserved, systematically organized, and have administrative, historical, or legal value. Archives can be in various formats, including physical and digital, and are used for various purposes, such as administrative activities, research, and preservation of collective memory [1], [2].

The importance of good archives management is to ensure the availability, usefulness, and sustainability of information for current and future generations. The development of information technology has driven digital transformation in archive management, which has now become a critical foundation for governance, organizational accountability, and the preservation of collective memory [3]. However, the dominance of conventional server-based centralized archive systems still presents serious challenges, such as vulnerability to cyber attacks, single point of failure risks, scalability limitations, and high operational and maintenance costs [4], [5]. ANRI (2022) data shows that 72% of government agencies experience archive access disruptions more than three times a year, with an average recovery time of 72 hours, which impacts public services [7].

The technology that can be applied in optimizing digital archive information systems is Irys Datachain. Irys Datachain is a blockchain designed for the purpose of storing data. Unlike blockchains that are optimized only for running smart contracts, where data storage is very expensive, datachains focus on storing data on the blockchain at an affordable cost. They enable the storage of large amounts of data without the excessive costs typically associated with



execution-focused blockchains such as Ethereum or Solana. Unlike other datachains that only store data, Irys Datachain not only stores data but is also dynamic and can interact with

other applications. Irys Datachain enables the handling of large data volumes without overloading the network, allowing for the scalable implementation of high-frequency systems or those requiring large amounts of data [4].

This study proposes a decentralized archival information system based on Iry Data chain to overcome the limitations of centralized systems, such as vulnerability to cyber attacks, single points of failure, integration and availability of archives, and operational cost efficiency [1], [5].

## 2. Methodology

The digital archive information system mechanism uses irys datachain, which is implemented entirely in the digital archive information system, so it does not use databases and servers like the archive information systems we are familiar with. The proposed digital archive information system is much simpler and consumes fewer resources, thereby minimizing costs.

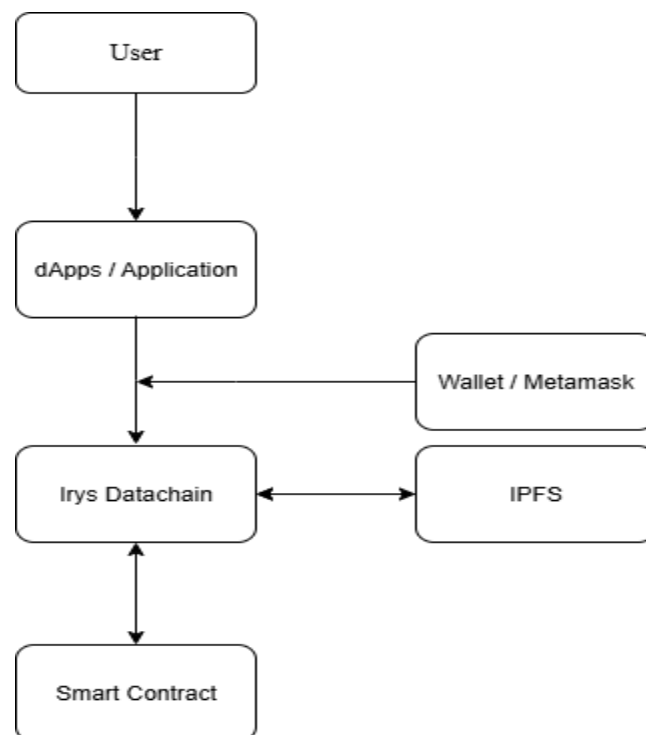


Figure 1. illustrates the digital information system.

This system is designed to optimize traditional digital archive information systems by implementing Irys Datachain. With this approach, the system guarantees security, availability, integration, and transparency without relying on a central server. In general, the proposed digital archive information system design consists of several main components, namely users, dApps or applications, wallets, Irys Datachain, IPFS, and smart contracts.

Users use wallet-based authentication or single sign-on (SSO). The main user roles consist of administrators, archivists, archive owners, and auditors. Role-based access control (RBAC) is implemented. dApps or applications serve as the main interface used to interact with the system. Users can upload documents (PDF, DOCX, and others), and the uploaded files will be encrypted. Irys Datachain is a Layer 1 blockchain focused on data storage. Uploaded files are stored on Irys Datachain. Each transaction on Irys incurs a transaction fee using

cryptocurrency. Each uploaded archive receives a unique and permanent transaction ID (TxID), file hash, and metadata, which are then stored on IPFS.

The stage of the methodology of this research can be seen in Figure 2.

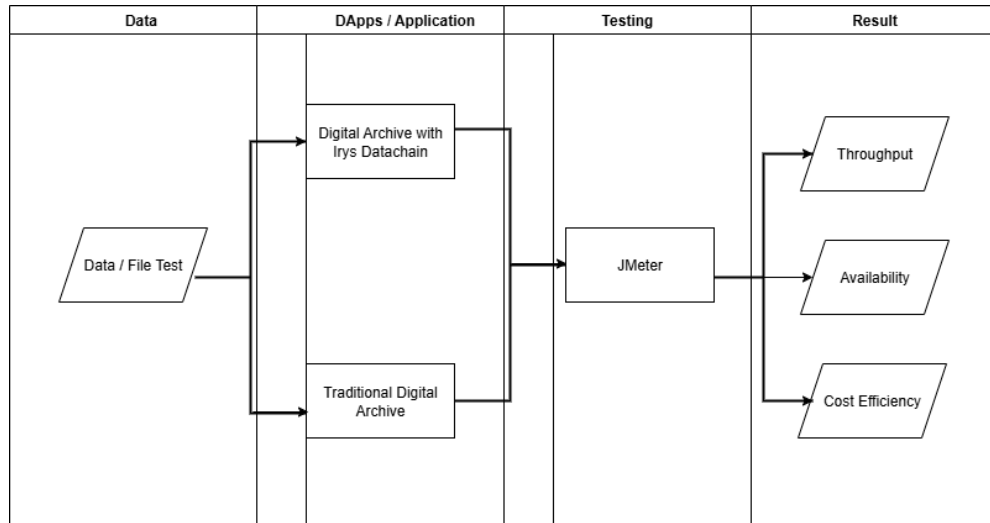


Figure 2. Stages of research methodology

In this research, the data used to conduct testing is a general file or documents like PDF or DOCX. To test and analyze the performance of the digital archive offered in this research, the digital archive offered will be compared with traditional digital archive with apple to apple condition. The test result will be analyzed quantitatively by taking the value of several parameters that will be displayed in tabular form. The analysis uses QoS (Quality of Service) namely Throughput and with that we can analyze availability and cost efficiency.

### 3. Result and Discussion

#### 3.1. Result

This session shows the results of testing the IRYS Datachain-based digital archive information system and the traditional archive information system. The testing was conducted using the same data over five iterations.

Table 1. Throughput Value of Testing Result

Iterations	Proposed System	Traditional System
Iteration 1	104 kbps	456 kbps
Iteration 2	61 kbps	785 kbps
Iteration 3	281 kbps	112 kbps
Iteration 4	113 kbps	411 kbps
Iteration 5	164 kbps	926 kbps

Table 2. Time Value of Testing Result

Iterations	Proposed System	Traditional System
Iteration 1	29.4 s	12.3 s
Iteration 2	17.7 s	15.0 s
Iteration 3	22.0 s	24.0 s
Iteration 4	27.6 s	12.5 s
Iteration 5	17.6 s	10.0 s

### 3.2. Discussion

The result of the research on all experiments conducted based on throughput and tim comparison between proposed system and traditional system obtained the following results that can be seen in table 1 and table 2. Looking at the table 1 and table 2. It shown that the traditional system has a much greater throughput with average 538 kbps compared to the proposed system with average 144.6 kbps. It is important to note that the throughput comparison between proposed system and traditional system may depend on many factors, such as network configuration, data size, and network resource availability.

### 4. Conclusion

In this research, we create a digital archives systems based on irys datachain that can overcome the problem of traditional digital archives systems like vulnerability to cyber attacks, single point of failure risks, scalability limitations, and high operational and maintenance costs, because in theory the proposed systems is able to overcome the problems.

This research will analyze the performance of the proposed systems by comparing it with traditional systems. The result show that traditional systems is better at data excecution where the average throughput is 538 kbps, while proposed systems only produces average throughput is 144.6 kbps smaller than traditional systems.

This can be caused by several factors, including network, where irys datachain to operate on unstructured global networks, which causes upload, search and download of data on irys datachain to take longer, affecting overall throughput. Although IRYS-based digital archive information systems can provide high availability, freedom from single points of failure, and low costs, traditional digital archive information systems are still the best choice when high performance is required. IRYS Datachain-based digital archive information systems can be an option if you want a system with high availability, freedom from single points of failure, and low operational costs.

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