

SECURE FREELANCER CONTRACT CREATION PLATFORM WITH DIGITAL SIGNING AND PAYMENT TRACKING

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ABSTRACT

The rapid growth of freelance and contract-based digital work has increased the need for secure platforms that can manage contracts, payments, and confidential document exchange. Traditional freelance management methods rely heavily on email communication, manual contract handling, and unprotected file sharing, which expose sensitive contractual and financial information to unauthorized access, data leakage, and manipulation. Most existing systems focus on workflow automation but provide limited encryption and insufficient control over document-level security. The traditional system lacks centralized access control, encrypted storage, and reliable audit mechanisms. Contracts and deliverables are often exchanged as plain files without cryptographic protection, making them vulnerable to interception and misuse. Password handling and role validation are frequently weak, and data storage mechanisms do not ensure confidentiality or traceability of user actions. To address these limitations, this research proposes a secure freelance contract management and encrypted file-sharing system developed using Python and the Flask web framework. The system implements role-based authentication for administrators, employers, and freelancers, supported by secure login sessions. Sensitive data such as files, confidential messages, and shared secrets are protected using ShangMi 4 (SM4) symmetric encryption with Secure Hash Algorithm 256 (SHA-256) derived keys before storage or transmission. User credentials are stored in hashed form to prevent direct exposure. The application uses TinyDB, a lightweight NoSQL database, to store users, contracts, payments, encrypted file metadata, messages, secrets, and

audit logs in structured JSON format. Encrypted files are stored in protected server directories, and access is strictly controlled based on user roles and ownership. Modular separation between the frontend, backend, encryption utilities, and database layer ensures secure and efficient workflow execution. This research enhances confidentiality, access control, and traceability while maintaining low computational overhead. It is suitable for academic environments and small-scale secure collaboration platforms, demonstrating the effective integration of encryption with web-based contract management systems.

Keywords: Freelance Contract Management, ShangMi 4 (SM4), Secure Hash Algorithm 256 (SHA-256), Role-Based Access Control (RBAC), Encrypted File Sharing, Flask Framework

1. INTRODUCTION

In the last two decades, new and contemporary occupational concepts have emerged in relation to general developments in information technology and the reorganization of work arrangements in the wake of digitalization. Digital technologies have made it possible for many things to be done online or remotely and for work to be broken down into smaller components called projects. Individuals are expected to become increasingly mobile and self-determined in terms of their careers, in contrast to traditional careers characterized by hierarchical advancement, organizational career management, and low mobility [1]. These flexible work schedules are often referred to as nonstandard and are performed by independent contractors called freelancers. In this paper, we use the term "freelancers" to refer to independent contractors of businesses

without employees who do not want to grow [2].

They aimed to examine the role of this particular type of entrepreneurial category of self-employment and their quality of life in terms of subjective (job and career satisfaction and life satisfaction) and objective (income satisfaction) success. Quality of life refers to the nonfinancial dimension associated with job satisfaction and life. In terms of work, quality of life refers to time and the opportunity to do what we enjoy [3]. Different jobs and occupations (careers) and working conditions are also important aspects of quality of life. Different types of jobs may require workers to work under extreme stress or do repetitive work. On the other hand, flexible work arrangements can provide professionals with more autonomy to perform their jobs [4].

In the past, career success was generally measured objectively (as wages, promotions). Today, however, new technologies and the changing nature of business are leading to a shift in the way success is viewed, and more importance is being placed on the more subjective component. According to [5], one of the most important resources affecting quality of life is satisfaction with work–life balance (i.e., the extent to which people feel they have control over their lives). In workplaces where people have a high degree of control over their working hours and other aspects of work, they tend to be more satisfied with the balance between their personal and professional lives [6, 7]. This relationship is usually explained by the fact that these individuals are better able to balance the spheres of work and nonwork because of their greater control over work. This raises the question of the quality of life of nonstandard workers, the freelancers. Since there is no scientific work and research on this topic in Slovenia yet, they first examined the selected demographic characteristics of freelancers in Slovenia, such as educational level, age, profession, work experience, and gender.

1.1 Research Motivation

Many real-time companies working with freelancers handle large volumes of contracts, payments, and confidential documents on a daily basis. Analyzing workflow inefficiencies and security incidents reveals the need for structured data handling and controlled access mechanisms. Data analysis helps organizations identify delays, payment disputes, and access violations across freelance engagements. Secure platforms also generate reliable audit data that supports operational decision-making. The motivation arises from the demand to integrate security, traceability, and efficiency into freelance management systems. This research is driven by the need to reduce risks while maintaining operational simplicity.

2. LITERATURE SURVEY

Tronconi et al. [8] aimed to compare and analyze the freelance and employment models for riders in different European countries in terms of social sustainability, i.e., work motivation and labor rights. To reach this goal, two activities were performed. On the one hand, qualitative interviews with German and Italian riders were carried out. On the other hand, a dynamic metaheuristic algorithm was developed and implemented to simulate an employment model with a central provider that managed order requests in real time. The qualitative interviews indicated that riders' motivations differed between freelance riders and employed riders: freelance riders did feel more controlled. Lukac et al. [9] used an empirically validated agent-based computational model to investigate the extent to which reputation systems could create segmented hiring patterns that were biased toward freelancers with good reputations. They explored how jobs and earnings became distributed on a stylized platform under different contextual conditions of information asymmetry. Their results suggested that information asymmetry influenced the extent to which reputation systems might lead to inequality between freelancers, but contrary to

expectations, lower levels of information asymmetry could facilitate higher inequality in outcomes. Ren et al. [10] conducted one of the few studies that addressed how freelancers' characteristics impacted the likelihood of being hired by employers using the theory of person–environment fit as a broad framework. Using Freelancer data, this research investigated whether country of residence (of a freelancer and the employer), amount earned, and time since registration on the platform were associated with the employment decision. The results indicated that country of residence did matter. Freelancers who tended to be from the same country as the employers were more likely to be hired. Likewise, high-income freelancers were less likely to be hired. Further, longer presence on the platform influenced the association between income level and likelihood of being hired. Gussek et al. [11] examined the challenges of IT freelancers and synthesized them. They extended the challenges of online freelancing already outlined in the literature and identified four IT-specific challenges for IT freelancers. Therefore, they improved understanding of how IT work was performed on digital labor platforms and which particular aspects should be considered in future research. Furthermore, they highlighted implications for practitioners, i.e., IT freelancers on the one hand and platform owners on the other hand. Zhang et al. [12] suggested that attention to the needs of different groups of platform workers, their diverse identities and interests, and labor equity and social protection was key to the sustainable development of the platform economy. The authors noted that future research could further prioritize cross-regional differences, algorithmic governance (including emerging technologies), the effectiveness of regulatory and organizational innovations in advancing labor equity and social protection, and the long-term, intersectional effects of platform labor, with a view to promoting a more inclusive and sustainable platform ecosystem.

Song et al. [13] reviewed the extant literature concerning crowd-based labor platforms and proposed a conceptual model detailing the relationship between justice perceptions and turnover within the crowd-based work context. Furthermore, they identified antecedents and moderators of justice perceptions that were specific to the crowd-based work context, as well as two forms of crowd-based turnover as a result of justice violations: requester turnover and platform turnover. In doing so, they provided a novel conceptual model for advancing research on crowd-based worker perceptions and turnover. Baitenizov et al. [14] identified the theoretical basis of freelance, its evolution, and intellectual capital as the foundation for the development of freelancing in new management and economic contexts. Based on these findings, the authors proposed the development of a multifunctional online freelance platform as a strategic initiative to support innovation-driven economic development in Kazakhstan. This paper contributed to the fields of innovation management, entrepreneurship, and the gig economy by framing freelancing as a dynamic, knowledge-intensive phenomenon with significant implications for future business models and labor market policies. Cieřlik et al. [15] shed light on the growth ambitions of different segments of solo self-employed workers by analyzing their varying expansion strategies. By estimating a multinomial logistic regression model on a large sample of solo self-employed workers, the main finding indicated that high-skilled solo self-employed individuals with a proven track record (by operating solo for at least five years) did not plan to hire employees. Instead, insofar as they had expansion plans, they preferred to work together with other self-employed individuals in networks or outsource tasks to subcontractors. The study highlighted the crucial role of collaborative networks, particularly among high-skilled professionals operating solo.

3. PROPOSED SYSTEM

This research is a role-based digital platform designed to manage users, contracts, files, payments, and secure communications in an integrated manner. It enables authenticated users to interact with system features according to their assigned roles. Sensitive data such as files and confidential messages are protected before storage to ensure data confidentiality. The system follows a structured request–processing–response workflow to maintain consistency and reliability. Data persistence is handled using a lightweight document-oriented database for simplicity and portability. Audit logging is incorporated to track system activities and enhance accountability, as shown in Fig. 1.

User Registration and Authentication: Users register and log in through a secure authentication mechanism. Credentials are verified before granting access. Successful authentication establishes a session used for further interactions.



Fig. 1: Proposed system architecture of secure freelancer contract creation platform.

Role-Based Access Management: After authentication, users are granted access based on predefined roles. Each role determines the set of allowed operations and visible modules. This prevents unauthorized access to restricted features.

Request Processing and Validation: User actions generate requests that are validated on the server side. Input data is checked for correctness and completeness. Only valid requests proceed to business logic execution.

Secure Data Handling and Storage: Sensitive information such as files and messages is processed securely before being stored. Data is saved in structured form along with metadata. This ensures confidentiality and organized persistence.

Business Logic Execution: The system processes core operations such as contract handling, payment tracking, and communication management. Logical rules govern state changes and data updates. Each operation follows a defined workflow.

Response Generation and User Feedback: After processing, the system generates appropriate responses indicating success or failure. Results are sent back to the user interface. Feedback messages guide users through subsequent actions.

Audit Logging and Monitoring: All significant system activities are recorded in log records. Logs include timestamps, user identity, and action details. This supports monitoring, traceability, and system analysis.

3.1 SM4 Encryption

SM4 is a symmetric block cipher that encrypts data using a 128-bit secret key and a fixed 128-bit block size. In the system, SM4 encryption is applied to sensitive data such as files, messages, and confidential inputs before storage. Plaintext data is first converted into a byte format and aligned to the required block size using padding. The prepared data blocks are then processed through the SM4 encryption rounds using the secret key. The resulting ciphertext ensures confidentiality by preventing unauthorized readability. Only encrypted data is stored or transmitted, protecting sensitive information at rest.

Plaintext Data Collection: Sensitive information such as textual data or file content is collected from user input or system modules. The input is treated as raw plaintext. This data forms the base input for the encryption process.

Byte Conversion and Preprocessing: The plaintext is converted into a byte-oriented format to make it suitable for block-level

encryption. This step ensures consistent handling of both text and binary data. Preprocessing avoids format-related encryption errors.

Block Size Padding: SM4 operates on fixed 128-bit blocks, so padding is applied when the data size is not an exact multiple of the block length. Padding bytes are appended to the plaintext to achieve proper alignment. This guarantees correct block-wise encryption.

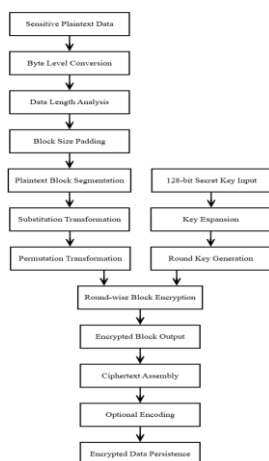


Fig. 2: Internal workflow of SM4 encryption.

Symmetric Key Preparation: A 128-bit secret key is prepared for the encryption operation. The same key is used across all encryption rounds. Secure handling of this key is essential to maintain data confidentiality.

SM4 Encryption Processing: The padded plaintext is divided into blocks and processed using the SM4 encryption algorithm. Each block undergoes multiple substitution and permutation rounds controlled by the secret key. This transforms readable plaintext into secure ciphertext.

Ciphertext Generation and Storage: All encrypted blocks are combined to generate the final ciphertext output. The ciphertext may be encoded if required for safe storage. Only this encrypted data is stored, ensuring sensitive information is never persisted in plaintext form.

4.3.2 SM4 Decryption

SM4 decryption is the reverse process of SM4 encryption and is used to restore encrypted data to its original readable form. It operates on a fixed 128-bit block size using the same 128-bit

secret key that was applied during encryption. The encrypted ciphertext is first prepared and divided into blocks for processing. Round keys generated from the secret key are applied in reverse order during decryption. Inverse transformation operations are performed on each block to recover the original plaintext structure as shown in Fig. 3. Padding added during encryption is identified and removed to obtain the final plaintext. This process ensures accurate and secure data recovery for authorized access.

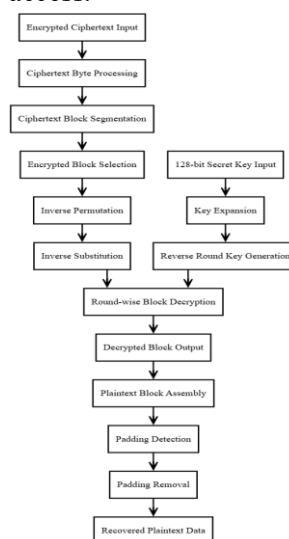


Fig. 3: Internal workflow of SM4 decryption.

Ciphertext Input and Preprocessing: Encrypted data is retrieved from storage and treated as ciphertext input. The data is converted into a byte-oriented format to support block-level processing. This step ensures compatibility with the decryption algorithm.

Ciphertext Block Segmentation: The processed ciphertext is divided into fixed-size 128-bit blocks. Each block is prepared for independent decryption operations. Block segmentation ensures orderly and consistent processing.

Secret Key and Reverse Round Key Generation: The original 128-bit secret key is provided as input to the key expansion mechanism. From this key, round keys are generated in reverse order. These reverse round keys control the decryption process.

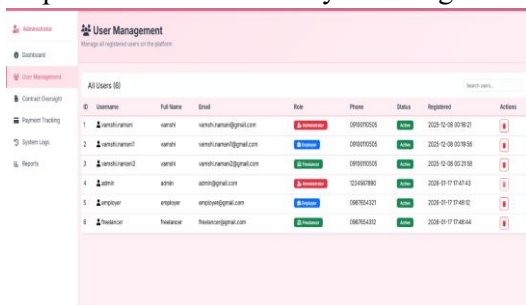
Inverse Transformation Operations: Each encrypted block undergoes inverse permutation and inverse substitution operations. These transformations undo the cryptographic mixing applied during encryption. This step gradually restores the original data structure.

Round-wise Block Decryption: The inverse transformations are applied iteratively across multiple decryption rounds. Each round processes the block using a corresponding reverse round key. This produces decrypted output blocks.

Plaintext Assembly and Padding Removal: All decrypted blocks are combined to reconstruct the plaintext data stream. Padding bytes added during encryption are detected and removed. The final output represents the original plaintext data in its correct form.

4. RESULTS AND DISCUSSION

Fig. 4 illustrates the User Management screen designed to manage registered users and their associated roles within the system. It supports administrative control over user accounts, permissions, and access rights to maintain platform security. The screen facilitates monitoring of user activity and ensures role-based segregation between administrators, employers, and freelancers. It contributes to secure identity management and accountability. This functionality is essential for maintaining compliance and controlled system usage.

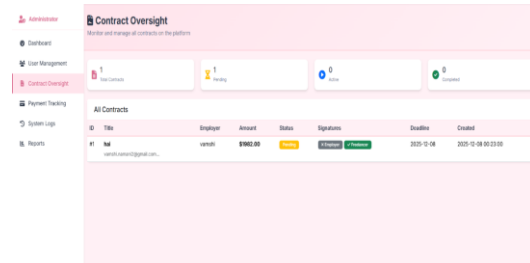


User Management							
Manage all registered users on the platform							
All Users (5)							
ID	Username	Full Name	Email	Role	Phone	Status	Registered
1	zesterauser1	zestera	zestera@gmail.com	Admin	0902000001	Active	2023-12-18 12:30:21
2	zesterauser2	zestera	zestera@gmail.com	Admin	0902000002	Active	2023-12-18 12:30:26
3	zesterauser3	zestera	zestera@gmail.com	Admin	0902000003	Active	2023-12-18 12:30:28
4	zestera	zestera	zestera@gmail.com	Admin	0902000004	Active	2023-12-18 12:30:28
5	zestera	zestera	zestera@gmail.com	Admin	0902000005	Active	2023-12-18 12:30:28

Fig. 4: User Management Screen

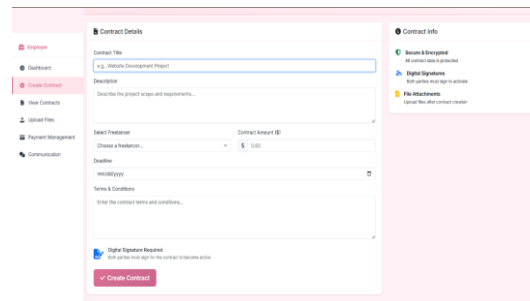
Fig. 5 depicts the Contract Monitoring and Managing screen used to oversee all contracts created on the platform. It provides visibility into contract status such as pending, active, and completed agreements. The interface enables administrators to track employer–freelancer

interactions and verify digital signature completion. It supports transparent contract lifecycle management under encrypted conditions. This screen ensures contractual compliance and secure agreement execution.



Contract Oversight							
Monitor and manage all contracts on the platform							
1 Pending		1 Active		0 Incomplete		0 Completed	
All Contracts							
ID	Title	Employer	Amount	Status	Signature	Deadline	Created
1	Freelance	zestera	\$500.00	Pending	zestera@gmail.com	2023-12-18	2023-12-18 12:30:28

Fig. 5: Contract Monitoring and Managing Screen



Contract Details

Contract Title

Description

Select Freelancer

Contract Amount (\$)

Deadline

Terms & Conditions

Digital Signature Required

Create Contract

Contract Info

Secure & Encrypted

Digital Signature

File Attachments

Fig. 6: Creating Contract Screen

Fig. 6 illustrates the Creating Contract screen used by employers to initiate new freelance agreements. It captures essential contract details including scope, freelancer selection, amount, deadlines, and terms. The screen enforces digital signature requirements before contract activation to ensure legal validity. It supports secure attachment handling under encryption mechanisms. This interface formalizes the secure contract creation process within the system.

Fig. 7 illustrates the Assigned Contracts screen that allows freelancers to view and respond to contracts allocated to them. It presents detailed contract information including employer identity, terms, deadlines, and payment value. The screen tracks the digital signature status required for contract activation. It ensures that agreements become valid only after proper authorization. This interface supports legally binding and secure contract acceptance.

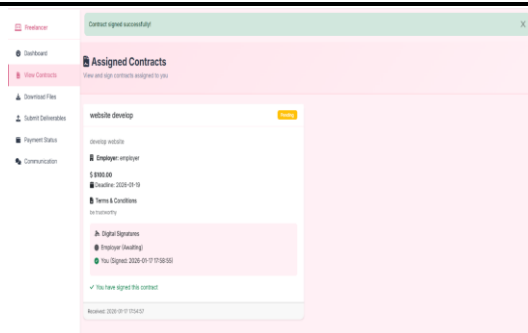


Fig. 7: Assigned Contracts Screen

Fig. 8 depicts the Submitting Deliverables screen used by freelancers to upload completed work securely. It enforces encryption of deliverable files using the SM4 algorithm before submission. The screen associates uploaded files with specific contracts to maintain traceability. It supports optional notes to clarify submission context. This process ensures confidentiality and integrity of transferred project artifacts.

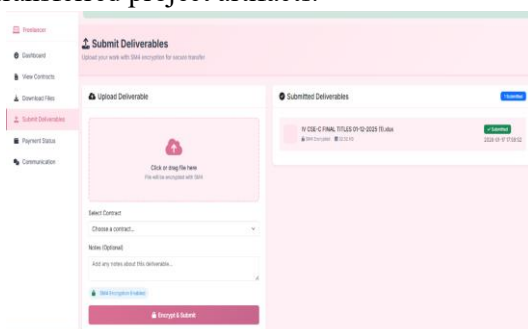


Fig. 8: Submitting Deliverables Screen

Fig. 9 illustrates the Payment Status screen that enables freelancers to track their earnings and payment history. It provides detailed records of completed and pending payments associated with contracts. The screen ensures transparency in financial transactions without exposing sensitive payment mechanisms. It supports accountability by displaying timestamps and transaction status. This functionality helps freelancers monitor compensation securely.

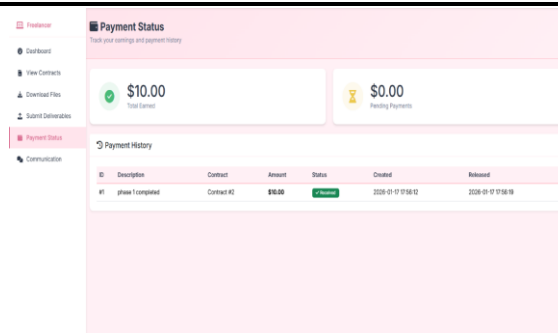


Fig. 9: Payment Status Screen

5. CONCLUSION

The research successfully implements a secure freelance contract management and encrypted file-sharing system using Python and the Flask framework, with SM4 symmetric encryption and role-based access control to protect sensitive contractual, financial, and communication data. The system enables administrators, employers, and freelancers to interact through well-defined workflows for user management, contract creation, digital signing, encrypted file exchange, secure messaging, and payment tracking. By integrating encryption at the file and message level, the system ensures confidentiality and controlled access throughout all operations. Performance improvements are achieved through the use of a lightweight Flask backend, efficient session handling, and TinyDB's low-overhead JSON-based storage, which reduces query latency for small to medium-scale deployments. Encrypting data only at critical storage and transmission points minimizes unnecessary computational overhead, while modular separation of encryption, routing, and database logic improves execution efficiency and maintainability. As a result, the system delivers secure operations with minimal performance degradation during file handling, messaging, and transactional workflows.

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