# Software Requirements Specifications

**AI and Blockchain-Based Certificate Verification System**

## Project Code:

BCV-AI-(25-26)

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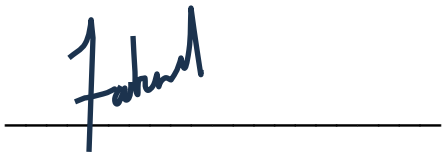

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# Definition of Terms, Acronyms and Abbreviations

*This section should provide the definitions of all terms, acronyms, and abbreviations required to interpret the terms used in the document properly.*

| Term | Description |
|---|---|
| AI | Artificial Intelligence – used to extract and process text automatically from certificates. |
| OCR | Optical Character Recognition – technology that converts text from images or PDFs into machine-readable text. |
| SHA-256 | Secure Hash Algorithm 256-bit – used to generate a unique digital fingerprint for each certificate. |
| RS | Requirements Specifications – this document outlining the complete system requirements. |
| ETH | Ethereum – a blockchain platform used for storing and verifying certificate hashes. |
| JWT | JSON Web Token – used for secure user authentication and session handling. |
| HTTPS | Hypertext Transfer Protocol Secure – ensures encrypted communication between client and server. |
| API | Application Programming Interface – allows communication between different software components. |
| DM | Project Manager – person responsible for supervising the development process. |
| DB | Database – where user credentials, logs, and verification records are stored (except blockchain data). |

# Table of Contents

# 1. Introduction

## 1.1 Purpose of Document

This purose of this document is to outline all of the features, functionalities, and requirements for the AI and Blockchain-Based Certificate Verification System. It describes what the system will do, how it will carry out its tasks, what issues it seeks to resolve, and how it will interact with users and other platforms.

Developers, testers, academic supervisors, and project stakeholders are the target audience for this document. It is a guide for the project's design, development, and validation stages. All of the

requirements listed here will help guarantee that the system is developed according to the user requirements.

## 1.2 Project Overview

The main aim of AI and Blockchain-Based Certificate Verification System is to create a secure, tamper-proof platform for verifying academic and professional certificates. Fake certificates and degrees have become a serious problem in Pakistan, with employers and institutions often struggling to confirm authenticity through slow manual processes[1] . This project combines AI and Blockchain technology to make the verification process fast, transparent, secure, and trustworthy[2].

Here's how the system works:

- Institutions or universities will upload and register certificates in system.
- The system will extract text from the certificates using OCR (Optical Character Recognition) and generate a unique SHA-256 hash for each [4].
- This hash will be stored on the Ethereum blockchain, it ensures the record cannot be altered.
- When a user or employer uploads a certificate to verify, the system will generates a hash and match it with the blockchain record.
- If the hashes match, the certificate is confirmed as authentic certificate . If not, it is fake or modified.

The goal of this system is to reduce human error, prevent fraud, and create a centralized digital verification solution that can be used across educational and professional sectors.

## 1.3 Scope

The system being developed, AI and Blockchain-Based Certificate Verification System, is designed to help organizations and individuals to verify academic and professional documents fast and secure.

**In Scope (What the system will do):**

- Allow registered institutions to upload and register certificates.
- Extract certificate data using OCR and generate a hash value.
- Store the certificate hash on the blockchain securily.
- Allow users or employers to upload certificates for instant verification.
- Display verification results ("Verified" or "Fake/Modified").
- Simple web-based interface accessible from all browsers.

**Out of Scope (What the system will not do):**

- Integration with national databases such as HEC or NADRA.
- Real cryptocurrency transactions (system will use Ethereum testnet only).
- Mobile application development (web version only for this phase).

- Editing or deletion of blockchain data once recorded.

By combining AI automation and blockchain's immutability, the system will provide a secure and efficient way to verify any certificate without relying on human or manual validation or any third-party services.

# 2. Overall System Description

The AI and Blockchain-Based Certificate Verification System is a secure, web-based platform designed to check the authenticity of academic and professional certificates. The system will use Artificial Intelligence (AI) and Blockchain together to prevent fraud and make the verification process automatic and transparent.

AI will handle text extraction through Optical Character Recognition (OCR), while Blockchain will record unique certificate hashes to ensure that once data is stored, it can never be changed or deleted [3].
This will help institutions, employers, and individuals to easily verify whether a certificate is real or not.

It will reduce the time and cost required for manual verification, providing a trustworthy digital alternative.

## 2.1 User Characteristics

The system is designed for three main types of users. Each group plays a different role in how the system operates.

### 2.1.1 Primary Users (Institutions / Universities)

- These users will register and upload verified certificates to the system.
- Each uploaded certificate will be processed through OCR and stored securely on the blockchain.
- They are responsible for maintaining the authenticity of uploaded data.
- Institutions include universities, training centers, and boards that issue certificates.

### 2.1.2 Secondary Users (Employers / Verifiers)

- These users will upload certificates submitted by job applicants or trainees.
- The system will automatically check and verify whether the uploaded certificate matches the one registered by the issuing institution or not.
- Employers or verification agencies can use this system to save time and avoid fake documentation.

### 2.1.3 General Users (Individuals / Students)

- These users can verify their own certificates to confirm that the record exists on the blockchain.
- They can view verification results but cannot modify or upload new records.
- Basic computer skills and internet access are sufficient to use this system.

## 2.2 Operating Environment

The system will run entirely on the web, accessible through desktop and mobile browsers. It does not require special hardware, only a stable internet connection.

### 2.2.1 Hardware

**Servers:** The backend will be hosted on a cloud server or a local test environment (e.g., AWS or PythonAnywhere).

**User Devices:** Any computer or smartphone with an internet connection can use the system. Only a working web browser is required.

**Storage:** Server storage will handle uploaded certificates and temporary OCR files.

### 2.2.2 Software

**Operating Systems:** Works on Windows, Linux, and macOS.

**Frontend:** HTML, CSS, and JavaScript for user interface.

**Backend:** Python Flask framework for handling requests and blockchain interaction.

**Blockchain:** Ethereum Test Network using Solidity smart contracts.

**OCR:** Tesseract OCR for text extraction from images or PDFs.

**Database:** SQLite or MongoDB for storing user and verification data.

**Browser Compatibility:** Chrome.

### 2.2.3 Network

- The system requires a stable internet connection for communication with the blockchain.
- Works on standard Wi-Fi or mobile data (3G/4G/5G).
- Blockchain confirmation times depend on network speed and testnet performance.

### 2.2.4 Security and Privacy

- Uploaded certificates and user credentials will be securely stored in the backend database.
- Only authorized institutions can register certificates; unauthorized uploads are blocked.

- Hashes on the blockchain will not contain personal data.

### 2.2.5 Language Support

- The primary language will be English.
- Future versions may include Urdu support for wider accessibility.

## 2.3 System Constraints

During design, development, and deployment, the system will face certain constraints and boundaries that define how it operates.

### 2.3.1 Software Constraints

- The system will only work on web browsers (no mobile app in this phase).
- Requires a solid internet connection for all blockchain-related tasks.
- Compatible with modern browsers only (Chrome).
- OCR accuracy depends on image clarity.

### 2.3.2 Hardware Constraints

- The hosting server must have sufficient CPU, RAM, and storage for blockchain transactions and OCR processing.
- Users need devices capable of uploading images.

### 2.3.3 Cultural Constraints

- The interface is initially available in English only.
- The system assumes familiarity with digital document handling and web interfaces.

### 2.3.5 User Constraints

- Users must know how to browse the web and upload files.
- Each institution or employer will need verified credentials to access the system.
- Users must have a reliable internet connection for verification requests.

### 2.3.7 Off-the-Shelf Component Constraints

**Tesseract OCR:** Accuracy depends on font clarity and image resolution.

**Ethereum Testnet:** May experience delays or limited access.

**Web3.py Library:** Requires proper version compatibility with the blockchain network.

**SHA-256 Algorithm:** Provides strong encryption but cannot prevent poor data input quality.

**Cloud Hosting Services:** Limited free-tier storage and API call restrictions.

# 3. External Interface Requirements

This section of document explains the hardware, software, and communication interfaces that the system will use to function properly.
The AI and Blockchain-Based Certificate Verification System will interact with user devices, online services, and the Ethereum test network to perform certificate verification smoothly and securely.

## 3.1 Hardware Interfaces

### 3.1.1 User Devices

- The system will work on standard desktop computers, laptops, and smartphones.
- Users will upload scanned images of their certificates from these devices.
- Any modern device with an internet connection and a web browser will support the system.

### 3.1.2 Scanner or Mobile Camera

- Users or institutions can use mobile phone cameras or document scanners to take pictures of certificates.
- The uploaded image must be clear enough for OCR to detect and read text correctly.

### 3.1.3 Server Hardware

- The system backend will run on a cloud server or a local hosted environment with enough storage and processing power to handle file uploads and blockchain operations.

## 3.2 Software Interfaces

### 3.2.1 Tesseract OCR Engine

- The system will use Tesseract OCR for extracting text from uploaded certificates.
- It converts certificate images into machine-readable text, which will then be processed for hashing and blockchain storage.

### 3.2.2 Python Flask Framework

- The backend web framework will be Flask, used to manage routing, handle user uploads, and communicate between the frontend and blockchain modules.
- Flask will also handle the API endpoints for certificate registration and verification.

### 3.2.3 Blockchain Smart Contracts

- The blockchain part will use Solidity for writing smart contracts on the Ethereum test network (Goerli or Sepolia).
- These contracts store and verify certificate hashes.
- The system will use the web3.py library to interact with the blockchain.

#### 3.2.4 Database

- The local backend will store basic user details and verification logs using SQLite or MongoDB.
- The blockchain itself will store only hashed certificate data, not full certificate content, to ensure privacy.

#### 3.2.5 Operating Systems and Browsers

- The system will work on Windows, Linux, and macOS through standard browsers like Google Chrome.

#### 3.2.6 Hashing and Security Libraries

- SHA-256 hashing algorithm will be used to create a unique fingerprint for each certificate.
- SSL/TLS encryption will protect communication between users and the server.
- JSON Web Tokens (JWT) will secure user authentication and session management.

### 3.3 Communications Interfaces

#### 3.3.1 Network Communication

- Communication between the frontend and backend will occur through RESTful APIs.
- Blockchain transactions will be sent through web3.py using Ethereum's JSON-RPC protocol.
- Every interaction with the blockchain will be verified before the result is shown to the user.

#### 3.3.2 Data Transfer

- After OCR processing, only text data and hashes are sent to the blockchain.
- The system will limit file uploads to a reasonable size to maintain performance.

#### 3.3.3 Synchronization and Response

The blockchain verification process depends on transaction confirmation time.
Once confirmed, the user will see a clear status:

"Certificate Verified"
"Certificate Not Found / Fake"

## 4. Functional Requirements

This section describes the main functional requirements of the AI and Blockchain-Based Certificate Verification System.
Each function defines a specific task or feature that the system must perform to ensure smooth and secure verification of certificates.

## 4.1 User Management

- Users (institutions, verifiers, and individuals) will be able to register and log in through a secure web interface.
- The system will allow verified institutions to create verified accounts for certificate uploads.
- Employers or verifiers can register to perform certificate validation checks.
- The system will store user details securely using encryption and hashed passwords.
- Each user will have a role-based dashboard according to their permissions .

## 4.1 Certificate Upload and Registration (For Institutions)

- Institutions will upload certificates in image format .
- The system will automatically extract text from the uploaded certificate using AI-based OCR.
- The extracted information will include details such as student name, ID, course title, and issue date.
- The system will generate a unique SHA-256 hash from the extracted data.
- This hash will then be sent to the blockchain and permanently stored using a Solidity smart contract.
- Institutions can view a list of uploaded and verified certificates on their dashboard.

## 4.3 Certificate Verification (For Employers / Verifiers)

- Verifiers can upload a certificate to check whether it’s fake or not.
- The system will extract text and generate a hash for the uploaded certificate.
- The new hash will be compared with existing hashes stored on the blockchain.
- If the hash matches, the system will display a “Verified” result.
- If no match is found, it will show “Fake or Modified Certificate.”
- The system will use an AI-based OCR engine to automatically extract text from certificates.
- OCR will detect and convert printed text into digital data.
- The system will clean and format extracted data before generating a hash.
- The OCR engine will support English text; future versions may include Urdu support.

## 4.4 Blockchain Integration

- The system will connect to the Ethereum test network (Goerli or Sepolia) [5].
- It will use Solidity smart contracts to store and verify certificate hashes.
- Smart contracts will handle the certificate registration and verification logic automatically.
- Each transaction will have a unique Transaction ID (TxID) visible to users for transparency.
- The blockchain will ensure that once a certificate record is added, it cannot be modified or deleted.

- Institutions can re-upload corrected certificates if necessary. This will create a new blockchain record with a different hash.

### 4.4 Admin and Monitoring Features

- The admin can approve or block institution accounts if misuse is detected.
- If OCR fails to read the certificate, the system will notify the user to upload a clearer image.
- Users will receive real-time error messages such as “Invalid File Type” or “Upload Failed.”
- All system messages will be displayed in simple and easy-to-understand English.

### 4.5 Data Storage and Privacy

- The blockchain will only store hashed certificate data, not personal or sensitive information.
- The backend database will store basic information such as user accounts and verification logs.
- Uploaded certificates will be temporarily stored on the server and deleted after hashing.
- No editable information will be stored on blockchain. All data will be unchanged once recorded.

### 4.6 Multi-Platform Accessibility

- The system will work on all operating systems including Windows, Linux, and macOS.
- It will run entirely in web browsers without needing any installation.
- The frontend design will be responsive for both desktop and mobile browsers.

## 5. Non-functional Requirements

This section defines the performance, reliability, security, usability, and compatibility standards that the system must meet. These requirements ensure that the AI and Blockchain-Based Certificate Verification System runs efficiently, safely, and consistently under different conditions.

### 5.1 System Performance

- The system should complete certificate verification within seconds of upload.
- OCR and hashing will be optimized to run quickly and smoothly.
- Web pages should load in less than five seconds on a normal connection.
- The backend should handle multiple requests at once without crashing or losing data.

### 5.2 Reliability and Stability

- The system should be up and running at least 95% of the time.
- It will be tested for stable performance with multiple users at once.

### 5.3 Data Safety

- Uploaded certificates will be deleted automatically after verification.
- Dangerous file formats won’t be accepted.

- Only administrators can access sensitive functions.
- Blockchain entries can't be changed or corrupted once confirmed.

### 5.4 Security and Privacy

- User passwords will be hashed with SHA-256 and never stored as plain text.
- JSON Web Tokens (JWT) will handle secure logins and sessions.
- Only verified institutions will have permission to upload certificates.
- No personal data will be written to the blockchain—only hash values.
- Input fields will be validated to block common web attacks like SQL injection or XSS.
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### 5.5 User Experience

- The interface will be clean and easy to follow for non-technical users.
- The verification process will include simple on-screen steps and progress updates.
- All notifications and error messages will be written in plain, clear language.

### 5.6 Accuracy and Validation

- OCR results will target at least 90% accuracy for English text.
- AI will recheck extracted information before generating hashes.
- All main details (name, ID, and course) must match before verification is marked as "authentic."

### 5.7 Legal and Ethical Compliance

- The system will follow Pakistani data protection and privacy standards.
- Institutions must be verified before uploading official records.
- Smart contracts will follow Ethereum's security guidelines.
- The system will include a disclaimer noting that results depend on genuine data from institutions.

### 5.8 Platform Compatibility

- Compatible with all major browsers (Chrome).
- Works across Windows, macOS, and Linux operating systems.
- Mobile-friendly design for Android and iOS browsers.

## 6. Assumptions and Dependencies

This section lists the assumptions made during development and the external dependencies that the project relies on for proper functioning.

## 6.1 Assumptions

**Internet Connectivity:**
Users have access to a stable internet connection since blockchain verification and certificate uploads require an online network.

**User Device Availability:**
Users and organizations will use modern devices with up-to-date browsers that support blockchain-based web apps.

**Institution Participation:**

Only verified educational institutions or organizations will register and issue certificates through the system.

**User Knowledge:**

Users are expected to understand how to upload files and use simple web applications.

**AI Model Accuracy:**

The AI-powered OCR and data extraction models will be accurate enough to read and interpret text from scanned certificates.

**Blockchain Access:**

The Ethereum test network or blockchain node will remain accessible during operation and testing.

**Legal Compliance:**

Institutions will provide legitimate data and comply with national privacy and educational data laws.

## 6.2 Dependencies

**Third-Party APIs:**

The system depends on external APIs such as OCR services for text extraction, and blockchain APIs (like Infura or Alchemy) for Ethereum transactions.

**Blockchain Network:**

The project relies on the Ethereum testnet (e.g., Goerli or Sepolia) for storing and verifying hashes. Any downtime or congestion could affect verification speed.

**Cloud Infrastructure:**

Hosting servers (e.g., AWS or Google Cloud) are required for system deployment, database storage, and backup operations.

**Development Tools:**
The project depends on frameworks like Flask for the backend, React for the frontend, and Solidity for smart contract integration.

**Financial Resources:**

Some components, such as blockchain gas fees or cloud hosting, may need small ongoing costs for deployment and testing.

**User Adoption:**

The system's success depends on educational institutions and employers adopting it as a trusted verification tool.

# 7. References


| Ref. No. | Document Title | Date of Release/ Publication | Document Source |
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