

Secure Credential Provenance Framework via Multi-Authority Trust Federation and Context-Aware Access Regulation

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ABSTRACT

The growing need for efficient and transparent public service delivery has exposed the inefficiencies of traditional paper-based certificate issuance systems, which are often characterized by manual processing, delays, poor inter-departmental coordination, and increased risk of data loss and fraudulent activities. Citizens frequently face inconvenience due to repeated physical visits, while authorities manage fragmented workflows with limited accountability. To address these challenges, this study proposes a digitally integrated multi-authority e-governance framework that transforms the entire certification process into a streamlined and automated system. The solution introduces a centralized web-based platform enabling seamless interaction among citizens, healthcare institutions, revenue departments, and administrative authorities, supporting end-to-end operations such as online application submission, document verification, approval workflows, and secure certificate issuance. The system is implemented using Django for backend development and MySQL (My Structured Query Language) for efficient data handling, along with Simple Mail Transfer Protocol (SMTP) for secure communication and notifications. A Role-Based Access Control (RBAC) mechanism ensures proper task allocation among stakeholders, while One-Time Password (OTP) authentication enhances the security of document access and downloads. By automating processes and centralizing operations, the framework reduces processing time, minimizes human errors, strengthens data integrity, and improves transparency through real-time application tracking. The proposed system provides a scalable, secure, and user-friendly digital infrastructure that enhances administrative efficiency and supports the advancement of citizen-centric digital governance.

Keywords: Multi-Authority System, Role-Based Access Control (RBAC), Django Framework, Data Integrity, Digital Governance.

1. INTRODUCTION

In the modern digital era, governments are increasingly leveraging advanced technologies to enhance the delivery of public services and strengthen interaction with citizens. Electronic Government (e-Government) initiatives focus on improving service accessibility, operational efficiency, and administrative transparency. A significant advancement within this domain is the integration of Artificial Intelligence (AI), which enables governments to deploy intelligent solutions such as virtual assistants and chatbots for citizen guidance, automated document processing systems for managing applications and licenses, fraud detection mechanisms in taxation and welfare programs, predictive analytics for public health and urban planning, and recommender systems that assist users in identifying relevant services or procedures [1]. These innovations collectively contribute to more adaptive, data-driven, and cost-efficient governance models.

Despite these technological advancements, their effectiveness largely depends on citizen acceptance and willingness to engage with such systems. Studies in e-governance highlight that successful adoption is strongly influenced by user trust, perceived usefulness, and ease of interaction [2]. Recent research

further indicates that trust in AI-driven government applications is shaped by ethical considerations and contextual trust transfer mechanisms. Models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) emphasize the critical role of these behavioral factors in technology adoption [9]. Additionally, transparency in system functioning and clarity in information dissemination are essential for fostering user confidence [3]. This becomes particularly important in AI-based applications, where concerns regarding fairness, data privacy, and the opacity of complex decision-making processes—often referred to as “black-box” models—are prevalent [4]. Consequently, factors such as trust, perceived benefits, risk awareness, digital literacy, and perceptions of fairness play a crucial role in shaping citizen attitudes, making them central to the development of responsible, inclusive, and widely accepted AI-enabled governance systems [5].

2. RELATED WORK

2.1 E-Government for Economic Development and Sustainability

Goloshchapova, et al. [9] conducted an in-depth analysis of the role of e-Government in driving economic development in the post-COVID context, emphasizing its importance as a modern administrative paradigm. Their study explained that e-Government leverages digital infrastructures and internet-based technologies to create efficient, transparent, and citizen-centric service delivery systems. They highlighted how digital platforms significantly reduce bureaucratic delays, enhance accessibility to public services, and support inclusive governance by reaching diverse population groups regardless of geographical or demographic barriers. Furthermore, the authors argued that e-Government contributes to macroeconomic growth by improving administrative productivity, enabling faster and more effective policy implementation, and fostering innovation within public sector operations. Their findings positioned e-Government as a critical enabler for resilient, adaptive, and sustainable governance in rapidly evolving socio-economic environments.

2.2 Evolution from Digital Government to Digital Governance

Erkut, et al. [12] examined the transition from traditional digital government models to broader digital governance frameworks, highlighting a fundamental shift from simple service digitization to holistic, data-driven governance ecosystems. Their study emphasized that while early digital government initiatives focused mainly on automating administrative services, modern digital governance incorporates continuous data exchange, stakeholder participation, and integrated policy-making processes. The authors discussed the “knowledge problem,” where decision-makers often operate with incomplete or imperfect information while still being required to make critical governance decisions. This issue becomes more complex in digital environments characterized by rapid technological evolution and uncertainty. To address these challenges, the study emphasized the need for adaptive governance frameworks that utilize real-time data, improve transparency, and support decentralized and flexible decision-making mechanisms.

Zhang, et al. [8] investigated the formation of rural digital governance platforms using a mixed-scanning–multiple streams framework, providing both empirical and theoretical insights. Their study demonstrated that such platforms play a crucial role in integrating fragmented administrative processes and enabling coordinated decision-making across multiple government entities. By leveraging digital technologies, these platforms improved resource allocation, reduced inefficiencies, and enhanced service delivery in rural regions. Additionally, the study highlighted that digital governance platforms contribute to sustainable rural development by improving infrastructure management, supporting local economic activities, and enhancing the overall quality of life. However, the authors also identified challenges such as limited digital literacy, insufficient technological infrastructure, and resistance to adopting new technologies, which can hinder effective implementation.

2.3 Trust and Citizen Behavior in Digital Systems

Wang, et al. [7] explored citizens' trust in AI-enabled government systems, emphasizing that trust is a fundamental determinant of both adoption and continued usage of digital governance platforms. Their study identified key factors such as system transparency, reliability, and perceived fairness as critical elements influencing user confidence. They highlighted that when users perceive AI systems as opaque or biased, their trust decreases significantly, even if the system demonstrates high performance. The study also emphasized the importance of data privacy and security, noting that concerns related to misuse of personal data can act as major barriers to adoption.

Hariguna, et al. [6] investigated the relationship between information system quality and citizen behavior within e-Government platforms, proposing an integrated framework that combines service quality with connection quality. Their study demonstrated that connection quality plays a crucial role in shaping trust and satisfaction. They found that high-quality systems not only improve service efficiency but also enhance user engagement and long-term usage. Furthermore, the study highlighted that trust acts as a mediating factor between system performance and behavioral intention, meaning that even technologically advanced systems may fail if they do not establish strong user trust.

2.4 Adoption Models and Service Quality Factors

Shareef, et al. [14] proposed the GAM, which provides a structured understanding of how different service maturity levels influence user adoption behavior. Their study explained that as e-Government services evolve from basic informational platforms to fully interactive and transactional systems, the factors influencing user adoption also become more complex. Key determinants identified include perceived usefulness, service quality, and trust. The model also emphasized that user expectations increase with service maturity, requiring more reliable, efficient, and user-friendly systems to ensure sustained adoption.

Alshehri, et al. [15] analysed the effects of website quality on the adoption of e-Government services using the UTAUT model and SEM. Their study demonstrated that factors such as system usability, information quality, and service responsiveness significantly influence user satisfaction and behavioral intention. They highlighted that well-designed interfaces, fast system performance, and accurate information presentation are essential for improving user experience. Additionally, the study emphasized the role of facilitating conditions, such as technical infrastructure and user support, in ensuring successful system implementation and usage.

2.5 Inclusiveness in Digital Governance

Al-Mamary, et al. [10] examined the concept of inclusive digital governance, emphasizing that accessibility and equitable service delivery are essential for successful digital transformation. Their study identified several critical factors influencing inclusiveness, including user awareness, availability of digital resources, system accessibility, and perceived compatibility with user needs. They argued that without addressing these factors, digital governance initiatives risk excluding certain population groups, thereby widening socio-economic disparities. The study highlighted the importance of designing user-centric systems and implementing supportive policies to ensure that digital services are accessible to all citizens.

2.6 Organizational Efficiency and Digital Transformation

Hakanen, et al. [13] explored factors influencing organizational engagement and productivity, highlighting the role of digital tools in enhancing information accessibility and internal coordination. Their study demonstrated that effective use of digital systems improves communication across organizational levels, reduces operational bottlenecks, and supports efficient decision-making

processes. They also emphasized the importance of digital self-service systems, which allow employees and stakeholders to independently access services and information, thereby reducing administrative workload and improving overall efficiency.

Goloshchapova, et al. [9] further reinforced that digital transformation in governance significantly improves administrative efficiency by reducing manual intervention and enabling faster service delivery. Their findings suggested that integrating digital technologies into governance processes enhances operational performance and strengthens the ability of institutions to respond to changing demands.

2.7 Research Gap

Existing studies have extensively addressed aspects such as trust, service quality, adoption, and efficiency in digital governance systems, but these elements are often explored independently rather than in an integrated manner. This creates limitations in developing systems that can simultaneously ensure high performance, user trust, and inclusiveness. Additionally, current models do not sufficiently address challenges such as interoperability between systems, data standardization, and scalability in dynamic environments. The integration of AI-driven decision-making with governance frameworks also remains underexplored, particularly in terms of transparency and reliability. Furthermore, practical implementation challenges, including ensuring data privacy, maintaining user trust, and supporting diverse user groups, continue to limit the effectiveness of digital governance systems. These gaps highlight the need for a unified, adaptive framework that can effectively combine technological capabilities with user-centric considerations.

3. PROPOSED SYSTEM

The proposed system architecture represents a comprehensive multi-authority e-Government framework designed to fully digitize and streamline the certificate issuance process through a centralized and role-based platform, as illustrated in Fig. 1. The system initiates with distinct login modules, namely Admin Login, User Login, Hospital Login, and Revenue Login, which enforce secure authentication and RBAC to ensure that each stakeholder accesses only their authorized functionalities. Built using Django as the backend framework, the architecture efficiently handles request processing, workflow management, and inter-module communication, while MySQL serves as the relational database for storing user credentials, application details, verification status, and activity logs in a structured manner.

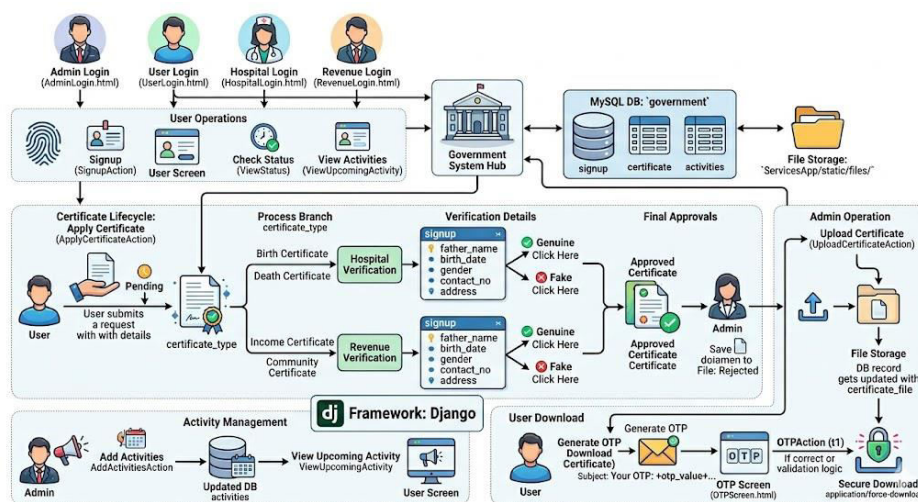


Fig. 1: Proposed system architecture

Once authenticated, users interact with the system via a web interface to register, submit certificate applications, track real-time status, and view system activities, with all requests being routed to the central Government System module that acts as the core coordination unit. Based on the certificate type, the system dynamically directs applications to the appropriate verification authority, where hospital officials validate birth and death certificates, and revenue authorities verify income and community certificates through domain-specific checks, marking applications as genuine or fake. Following successful verification, the admin module performs final validation, generates certificates, and securely stores them in a file storage system linked with the database, ensuring proper indexing and retrieval. The architecture further integrates SMTP for automated notifications and communication, particularly for delivering OTP required for secure certificate download, thereby preventing unauthorized access. Additionally, an activity management module enables administrators to update system events and allows users to view notifications, ensuring transparency and continuous engagement. By combining centralized control, distributed verification, secure authentication, and automated communication, the system significantly reduces manual effort, minimizes processing delays, enhances data integrity, and provides a scalable, secure, and efficient digital governance solution.

The main features of proposed web application are as follows:

- **Multi-Role System:** The research distinguishes user roles with separate login pages and tailored dashboards. Users apply for certificates, hospital and revenue officials verify and approve applications, and administrators manage certificate uploads.
- **Certificate Workflow Automation:** Users submit certificate applications, which are checked for duplicates and tracked for status updates. Officials approve or reject applications based on the certificate type. Approved certificates are uploaded by admins and made available for secure download by users.
- **Security Features:** Downloads are protected by an OTP sent via email, ensuring only authorized users access their certificates. The system maintains audit trails of approval statuses and upload history.
- **Database Integration:** The system uses MySQL to store user data, applications, certificate statuses, and activity records, queried dynamically to provide real-time user and admin views.
- **User Interaction:** Users can sign up, log in, view application statuses, apply for new certificates, and securely download approved certificates. Admins can add upcoming activities/events relevant to users.
- **File Management:** Certificates are stored as files on the server with management for overwrites and deletions to handle updates efficiently.

This system serves as a comprehensive digital platform for government entities and citizens, enhancing transparency, accuracy, and efficiency in certificate management through role-based workflows and secure communication protocols. It streamlines the cumbersome manual certificate issuance process into a responsive, user-friendly online application.

3.1 RBAC and Authentication

RBAC as shown in Fig. 2 ensures that users, admins, hospital officials, and revenue officers have access only to the functions pertinent to their role. It strengthens security and operational boundaries by separating privileges.

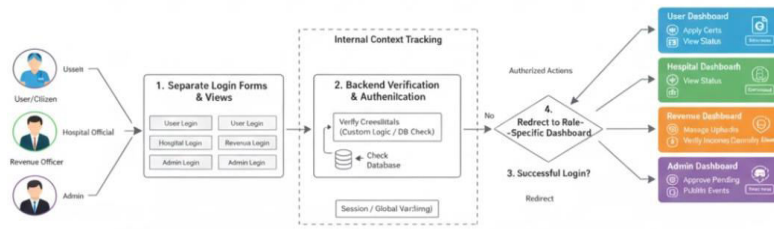


Fig. 2: RBAC and authentication.

The internal operational flow is as follows:

- Separate login views and forms capture credentials for each user type.
- The backend verifies inputs against stored credentials (manual verification, not Django's default auth).
- Post-login, users are redirected to role-specific dashboards.
- Each role views filtered data and performs authorized activities (e.g., hospitals verify birth certificates).
- Session or global variable (uname) tracks the logged-in user context internally for request handling.

4. RESULTS DESCRIPTION

Fig. 3 depicts the application status page where submitted requests are recorded along with key attributes such as applicant name, certificate type, applied date, and current processing state. It illustrates the transparency mechanism that allows users to track the progress of their application within the system. The figure emphasizes how pending requests are maintained and displayed systematically for user awareness. It also represents the system’s ability to manage and update application records dynamically.

Person Name	Description	Certificate Type	Applied Date	Status	Download
manaswi	I need my birth certificate for visa process	Birth Certificate	2025-11-22	Pending	--

Fig. 3: Status page after applying for certificate.

Fig. 4 illustrates the verification interface used by hospital authorities to review submitted certificate requests along with detailed applicant information. It depicts how essential attributes such as personal details, contact information, and supporting data are presented for validation. The figure highlights the evaluation process where authenticity is assessed through genuine and flagged data indicators. It represents the intermediate validation stage within the certificate processing pipeline.

Username	Description	Certificate Type	Applied Date	Father Name	Birth Date	Gender	Contact No	Address	Genuine Details	Fake Details
manaswi	I need my birth certificate for visa process	Birth Certificate	2025-11-22	mahesh	4-6-1991	Female	9000188676	Simhapuri Colony, Bowrampet	Genuine Click Here	Fake Click Here

Fig. 4: Illustration of certificate request by hospital authority.

Fig. 5 depicts the updated user status view after administrative approval, where the application transitions from a pending state to an approved state. It illustrates how the system reflects the final decision and enables access to the certificate download option. The figure emphasizes the completion stage of the workflow, where approved requests are made available to users. It also represents the successful integration of validation and approval mechanisms within the system.

Person Name	Description	Certificate Type	Applied Date	Status	Download
manaswi	I need my birth certificate for visa process	Birth Certificate	2025-11-22	Approved	Click Here

Fig. 5: Updating of user view status as approved and showing the certificate download option.

Fig. 6 illustrates the administrative approval management interface where authorities oversee and process certificate applications. It depicts how records are organized and displayed for efficient review and decision-making. The figure highlights the centralized control mechanism that enables administrators to update application statuses and manage workflow progression. It also represents how approval actions are reflected consistently across the system.

Username	Description	Certificate Type	Applied Date	Status	Certificate Filename	Upload Certificate
manaswi	I need my birth certificate for visa process	Birth Certificate	2025-11-22	Approved	Pending	Click Here

Fig. 6: View approvals page from admin authority.

Username	Description	Certificate Type	Applied Date	Father Name	Birth Date	Gender	Contact No	Address	Genuine Details	Fake Details
mahesh	I need community certificate	Community Certificate	2025-11-22	mahesh	25-3-1990	Male	9000188676	Simhapuri Colony, Pragathi Nagar	Genuine Click Here	Fake Click Here

Fig. 7: Illustration of community certificate request by revenue department authority.

Fig. 7 depicts the submission and verification process for community certificate requests handled by the revenue department authority. It illustrates how domain-specific applications are processed with detailed applicant information and contextual attributes. The figure highlights the system’s capability to support multiple certificate categories within a unified framework. It also represents the consistent application of verification procedures across different administrative departments.

5. CONCLUSION

This research enhances public service delivery by digitizing the entire certificate issuance, verification, and download process. It replaces manual procedures with an automated system that improves accuracy, efficiency, and processing speed. The framework incorporates role-based access control, enabling different authorities to handle verification tasks in a structured manner. Citizens can apply for certificates online and track their status in real time, ensuring transparency throughout the workflow. The system also integrates OTP-based authentication to provide secure certificate access and prevent unauthorized downloads. Built using the Django framework, it ensures scalability, modularity, and

reliable performance. MySQL supports efficient data storage, while SMTP enables secure communication for notifications and OTP delivery. Overall, the framework reduces delays, minimizes human errors, and strengthens trust in digital governance systems.

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