A Secured Cloud-Based Electronic Document Management System

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Abstract:
Documents stored and managed on paper are characterized by lots of inefficiencies and work-related issues such as high time consumption, errors, and redundancy during information collection, storage, and retrieval. Producing documents using computer-supported methods has become common practice in the institution but the management of documents is still done with manual methods. It is also worth noting that the increased volume of document production and distribution through e-mail systems and workstation-based file managers has aggravated problems in document security, control, tracking, and retrieval. In this work, a secured cloud-based electronic document management system was designed (SECEDOMAS). The system consists of three processes, namely:

- *The document entry process,*
- *Electronic document management system (EDMS), and*
- *Document retrieval and sharing process*

The system was implemented using HTML, CSS, JavaScript, Laravel (PHP framework), and MySQL. An Advanced Encryption Standard (AES) algorithm was used to encrypt the documents stored and shared to prevent the documents from unauthorized users. The system was tested using the document of exams and records unit of Olusegun Agagu University of Science and Technology, Okitipupa. The performance shows that it is effective in storing, retrieving, and sharing processes. SECEDOMAS is well-structured, more efficient, secure, and durable.

Keywords: Cloud, electronic, document, management, security

1. Introduction

According to Levien (1989), any information that is recorded and structured into a unit for the purpose of human consumption is referred to as a document. Organizing and extracting documents/records from large volumes of physical documents are very difficult. It is possible for documents to be misplaced or even get lost, and they are also prone to human error (Akashah et al., 2011). Many years ago, organization documents were stored and managed on paper, usually regarded as a manual approach, and this approach is characterized by lots of inefficiencies and work-related issues such as high time consumption, errors, and redundancy during information collection, storage, and retrieval (Mehandjiev et al. 2013, Balogun, et al. 2019). Heckman (2008) was of the view that without the use of an efficient and effective document management system, it is almost certain that the management of documents will always be prone to human error.

As students pass out each year from the institution, their records in the record department increase tremendously. With the increase in the number and size of archives in the institution's records department, each file contains approximately 200 documents in different sizes, and the slowness in dealing with the current archiving system, increased costs, and the possibility of losing its contents and the paper document getting damaged makes it more complicated to use. Furthermore, the increased volume of document production and distribution has aggravated problems in document security, control, tracking, and retrieval.

Michalski (1991) argues that document processing by the use of technology has greatly transformed the role played by documents in an organization from the very traditional paper-based record keeping to a more sophisticated and complex content information processing and management that entail a wide variety of graphical, video, audio, animations, images, processed for different organizational uses such as reports, contracts, handbooks, correspondences, memos, e-mail, etc. in such a way that can be electronically generated, processed, stored, disseminated and displayed.

Document management systems have been seen as the solution to many paper-related problems, and they seem to offer the highest degree of control over the ways in which paper documents are handled. It should be noted that document management systems manage documents and not the information or knowledge contained within the documents (Yatin et al., 2015).

A lot of organizations/institutions have used paper files and folders for hundreds of years which had been part of them. However, with the emphasis now on rendering services online using modern communications methods such as the Internet and mobile phone-based services, this gives rise to the need for electronic document and records storage to quickly and efficiently access whatever information is needed by the citizen (client) to deliver the services required (Adam, 2008). Due to the dynamic nature of modern organizations that require enterprises to maintain electronic documents to ensure interoperability of services, compete favorably, and share information seamlessly, it is necessary for all organization-related information to be collected, stored, retrieved, and shared in a digital form (Mehandjiev et al., 2013). Accordingly, it is also essential for organizations to access information as soon as possible to facilitate better decision-making (Abaci, 2020).

Electronic Document Management System (EDMS) uses new information communication technology (ICT) to process documents in such a way that public service performance and productivity are greatly enhanced. New advances in this field have led to the development of more powerful EDMS with greater capabilities that transcend beyond the traditional text-based document generation, printing, and distribution, to a more sophisticated and advanced computer-based or knowledge-based information systems capable of eliciting, processing, analyzing, saving and disseminating information in high communication speeds and presenting them in knowledgeable contexts useful to the user and policymakers (Levien, 1989).

An EDMS provides many advantages including management support, budgetary, security, cooperation, performance, privacy, and systems integration (Abdulkadhim et al., 2015). EDMS is an important element in establishing a repository and transforming the capabilities of the organization and its workforce.

Nowadays, it is also worth noting that the increased volume of document production, publication, and corporate-wide distribution through e-mail systems and workstation-based file managers has aggravated problems in document security, control, tracking, and retrieval (Sutton, 1996). Likewise, storage systems are increasingly subject to attacks, so as a result of this, data storage needs to be secure. For security purposes, cryptography techniques can be employed (Kahanwal et al., 2012).

In a bid to address these pressing needs, a secured cloud-based electronic document management system was developed. The system contains tools for converting paper documents into digital assets, organizing them in standardized file structures and formats, and storing, securing, and accessing information by authorized workers. The new system is easy to use, reliable, efficient, and more secure.

The work is organized as follows:
- A brief overview of literature is given in section 2.
- Section 3 provides a methodology for a secured cloud-based electronic management system.
- The implementation and results are given in section 4.
- Section 5 concludes the research work.

2. Literature Review

Gabrielaitis and Bausys (2006) developed a dynamic archive with information flows in both directions of the design process chain that is consumer design archive. The design documentation is based on a reference model for an Open Archival Information System (OAIS).

All the data are well-stored in the system, but there is no provision for document signatory/authentication; hence, no security measure was put in place.

Park and Kim (2010) proposed a scrambling encryption technique in which a user (while issuing a registered e-document to a third party) can send partial data of the document to prevent information leakage and improve document readability. A hash function was used to change the values of image pixels to replace the image. Although the image files are well-secured, the scrambling encrypting method employed in this system can only be used in low-specification mobile devices, and the encryption techniques are targeted at image file format only.

Interpares 3 Project (2012) designed and implemented a record system for the entire organization considering both paper and electronic records. In the first step, the functional software requirements are identified as both archival and technological. The main archival requirements are registration, classification, and filling, retention and disposal, security controls, search and retrieve, and elaboration of reports and statistics, while the main technological requirements were related to application platforms, management of e-mails, formats, records and authentication and others such as records transfer and export, remote work. Although the system preserved the institution's record with enduring valves, there is no digital signatory on the document.

Kodmelwar et al. (2012) designed a document management system for small to medium-scale enterprises with a special emphasis on security, and the system keeps track of the versions of a particular document over time.

Akor et al. (2013) investigated the role of assessing the record management of two Universities. In their work, four (4) research questions were carried out. The population sample comprised staff from the establishment division of the Universities, and the instrument used for data collection was a questionnaire. Frequency and percentages were used to analyze the research question. The system has accurate and up-to-date information that ensures better service to the communities, but it can lead to disastrous situations in the future.

Anwar and Ahmed (2013) proposed an e-Course file management system to shift from a current method of compiling paper-based course files to a more versatile method of compiling and maintaining electronic course files. The system reduces the human and financial resources needed for compiling course files, minimizes the negative environmental impact, saves natural resources for future generations, and contributes towards a green sustainable environment. However, the e-course files cannot be accessed or shared with other departments that are in need of it.

Mahmood and Okumus (2017) developed an electronic document management system that provides users in the institution with a simple and efficient mechanism to access, manage and share their documents. However, this system does not support e-mail and message facilities outside the system.

Rosa et al (2019) proposed a system that was used for managing and capturing both images and digital files of scanned documents. The system has a mobile app that offers full mobile access and online support. Documents can be accessed from any device that is internet enabled. The system lacks the convenience of a document management system because documents need to be downloaded before they can be used, and it has only e-mail customer support and no phone support.

Vilkov et al. (2019) considered a method for organizing product data and its basic tool for implementing a single source in the form of a document management system. It involves processing a large amount of information, but the information stored is not secured.

Odeh and Odeh (2019) proposed a system that will serve academic staff in organizing their course files and provide many different functions related to management staff. The course file is accessible at any time and from anywhere, but the signatory is carried out manually, and the system is not secure.

As a result of the challenges faced by the organization/institution, some limitations in the existing document management approach, and the need to improve on it, a secured cloud-based electronic management system was developed. The system can store and secure documents according to standardized compliance rules, share digital documents with the right knowledge workers, and use a reliable, secure, and efficient database handling a large amount of data.

3. Design Methodology

3.1. Design Consideration
The following are included in the system.

3.1.1. Security
This is an absolute necessity for any electronic document management system. A strict security system allows authorized persons to perform the necessary duties. Before the file can be transferred, it must be encrypted for security purposes. Likewise, document access is restricted to the authorized department (even within the organization) and for the authorized employee/staff only.

3.1.2. Level of Abstraction
This feature ensures that document access is restricted to the authorized department (even within the organization) and for the authorized employee only.

A staff working on a client machine will store and retrieve documents within their own directory stored inside the department. The system allows a staff to access only their files and not of any other staff. Also, files from one particular department will not be authorized for staff of the other department. Documents that are common to all departments will be put in a common directory to which every staff has access.

3.1.3. Workflow Services
This feature of the system allows users to route files from worker to worker in an organized way which includes the ability to prioritize the sending of files based on the sender-designated hierarchy order.

3.1.4. Signature and Comments Request
The system enables users to endorse signatures and make comments on the document before it is forwarded to the intended users in the organization. The system keeps track of the files sent and forwards a copy of the document to the sender's e-mail.

3.1.5. Data (File) Compression
This feature compresses the size of the encrypted file that resides on the server since the encrypted file has a larger size than the plaintext file. Thus, compression allows us to optimize the size of the encrypted document. The system uses the base64 compression technique as it gives us a fair ratio of the size of the data (file) and the time required to compress it when compared with other popular compression techniques.

3.1.6. File Versioning
This feature of the system keeps track of the versions of a particular document over time. Staff working on a particular document over a period of days may want to revert to a previous version of the same file. For this, the server will keep multiple copies of the same file on it.

3.1.7. Data Recovery

This feature makes it possible to restore data that has been lost, accidentally deleted, corrupted, or made inaccessible. Common causes of data loss include power outages, natural disasters, equipment failures or malfunctions, accidental deletion of data, software crashes, and logical errors. However, this system takes care of these incidents and the information about that file is stored in different places.

3.1.8. File Categorization

This feature of the system allows the users to assign file types and groups based on the criteria that they choose and also separate them by folders and categories.

3.2. Architecture of a Secured Cloud-Based Electronic Document Management System

The architecture of a secured cloud-based electronic document management system (SECEDAMAS) is shown in figure 1. The system comprises document entry process, Electronic Document Management System (EDMS), and document retrieval and sharing process. The document entry process is made up of the document and the web-based interface. The EDMS comprises the document upload process, search engine, security protocols, file server, database server, and DMS server.

The document can either be internal or external. After the document has been created, the user goes online and uploads the document through the web-based interface. During document uploading, the user needs to fill in some data fields that provide the metadata or indexing tags (e.g., file name, folder name, document description) associated with the specific document being uploaded, which will facilitate retrieval of the document. The user also assigns the user groups that will have access rights (e.g., to view the document, add a new version, etc.) to the document. At this stage, naming the document correctly using the correct naming convention is critical so that the document will be easy to retrieve after it is uploaded.

The security protocol employed in the system is encryption and authentication. This system leveraged AES-256 and AES-128 encryptions provided by Laravel (a PHP framework), which provides us with a powerful encryption service. It uses Open SSL for encryption and Base64 for encoding the files on the server. All the values included in Laravel are signed using the protocol message authentication code so that the underlying value cannot be tampered with once encrypted. The encrypted and encoded document/file is then stored in the file server. The file server, therefore, offers users a central storage place for files on internal data media, which is accessible to all authorized users. The database server is used to store system data and operate the entire system. The reason behind using this server is to increase system security and archiving. The database comprises both the data sets and the database management system software that manages and provides access to the data (back-end).

When documents are stored in the cloud, they are available for retrieval and sharing through the web-based interface where users can search for documents using the search engine. The security settings determine if documents will be made available to users (then the documents opened on the users' screens) and if the documents can be shared.
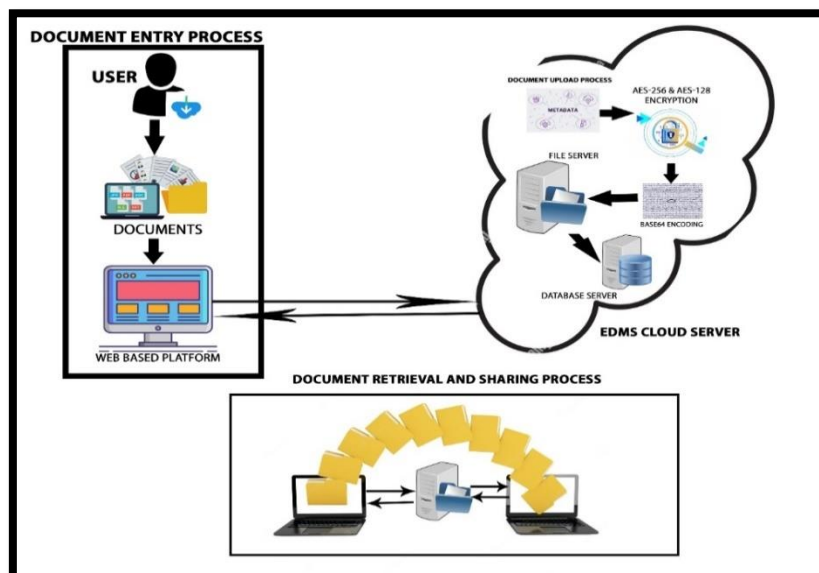

Figure 1: Architecture of Secured Cloud-Based Electronic Document Management System (SECEDAMAS)

4. Implementation

SECEDOMAS was developed and implemented with Hypertext Markup Language (HTML), Cascading Style Sheets (CSS), BOOTSTRAP, Laravel (PHP framework), JQuery, and MySQL (RDBMS).

4.1. Preliminary Testing of a Secured Cloud-Based Electronic Document Management System

It describes how the secured cloud-based electronic document management system was created and used. It consists of different modules and interfaces for easy communication and usage.

The Admin Dashboard, shown in figure 2, is a page that is generated after a successful login by the Administration having duly registered. It has all the menus that can be used to access all the systems functions and control all activities within the system. While figure 3 shows the head of the department or unit dashboard. This is a page that is generated after a successful login by the Head of Department (HOD) after due registration. It consists of the following menus: departmental documents, staff, student, categories, and log functions.
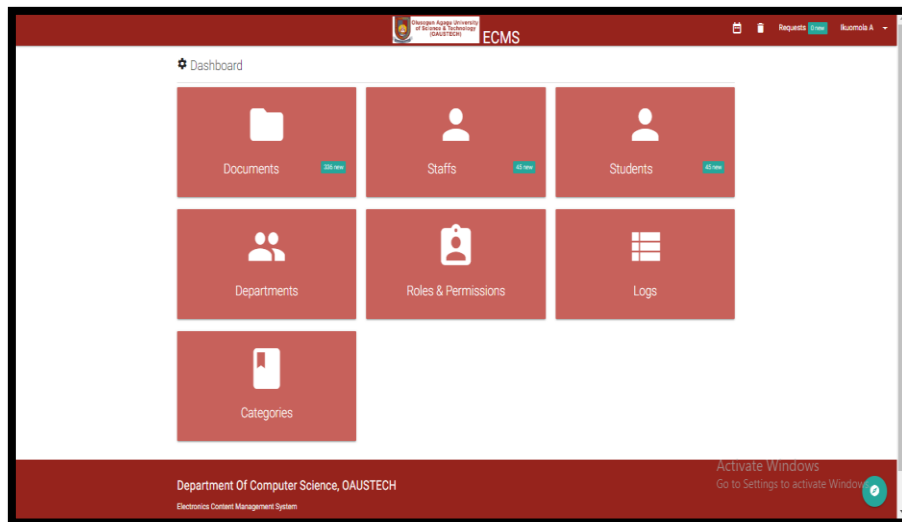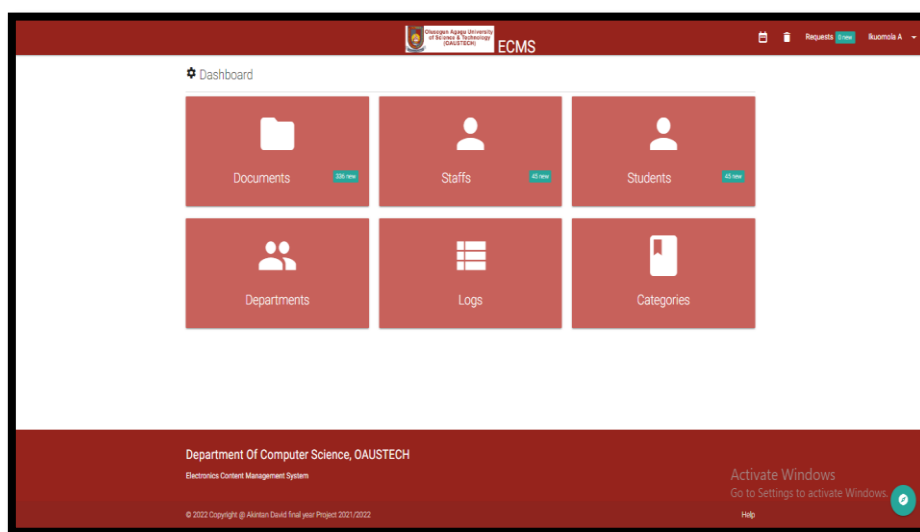

Figure 2: Admin Dashboard

Figure 3: HOD Dashboard

In the process of uploading documents, the documents can be either internal or external. The internal document is in the form of a softcopy which is created by system users, while the external document is in the form of a hard copy that can be scanned and imported into the system.

Figure 4 shows the document scanning page where users are allowed to scan external documents (hardcopy) directly from the scanner and upload the scanned document into the database, while figure 5 shows the file upload page, which allows the users to upload the internal document (softcopy) into the system.
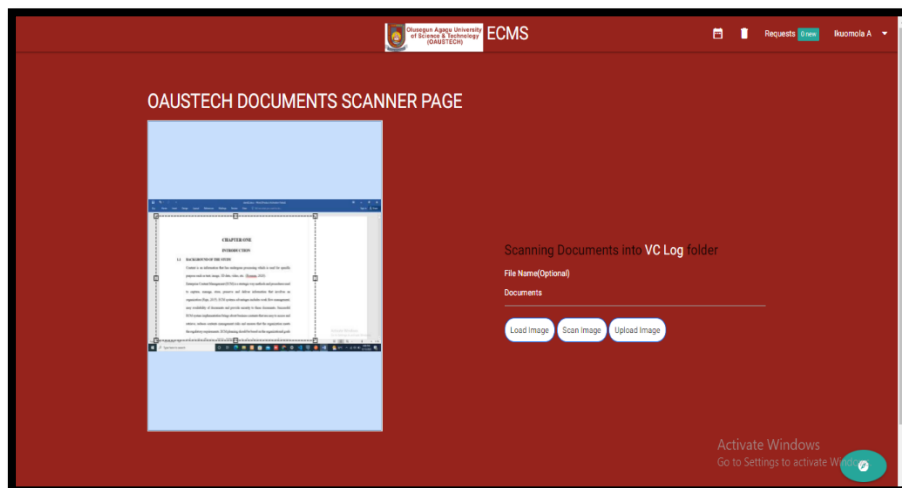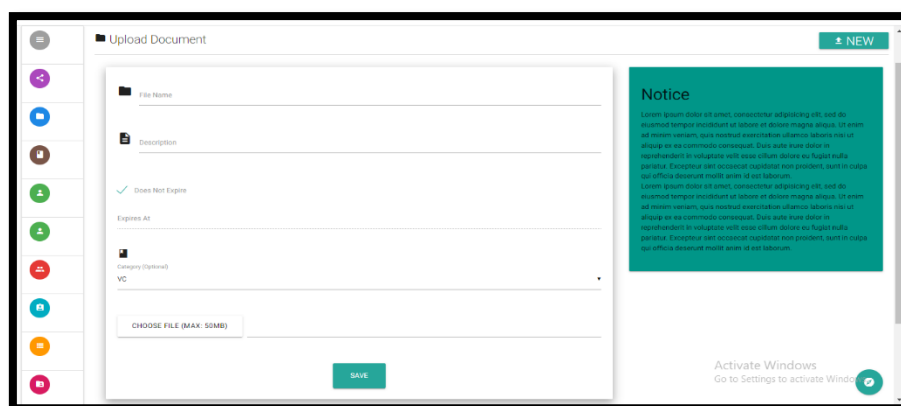
Figure 4: Document Scanning Page

Figure 5: File Upload Page

Document sharing is possible through the share file page, as shown in figure 6, where users can share information with other users.
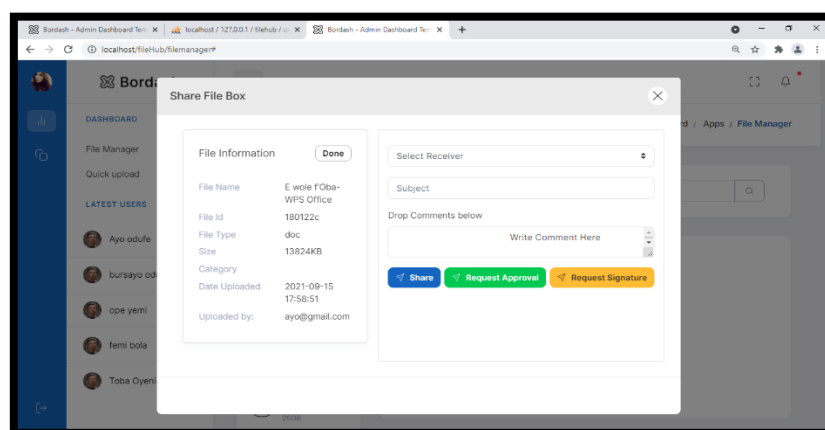

Figure 6: Share File Page

This work aimed at developing a secured cloud-based electronic document management system for Olusegun Agagu University of Science and Technology, Okitipupa. The work solved the challenges faced by users with the current method used. The benefits of using the developed application for the institution/organization include:

- The system enables the generation of digital assets from paper documents
- Provision of a robust database for archiving available documents in the institution.
- Provision of timely access to information by management and authorized workers for quick decision making
- Provision of low-cost technology for documentation
- Generation of audit trails that automatically track exactly how information is being accessed for ongoing regulatory compliance
- Generation of check-in and check-out features to ensure information integrity and streamline collaboration

- This work allowed the organization to uniquely secure documents and ensure that limited space is used. It makes sure that only authorized users can gain access to services.
- It provides an efficient mechanism to store, retrieve and share documents
- It provides seamless sharing of documents between staff
  The security pillars of the SECEDOMAS are:

4.1.1. Identification
This is a very important step for ensuring data confidentiality and isolation among many users. This is needed to ensure that a specific user can only have access to their own data without interfering with any other users using the application. When a user tries to access the application, the user identifier module looks up at the user's username and password in the database. If it is found, then the user can have access to the application; otherwise, a 404-Not found HTTP response is displayed.

4.1.2. Authentication
For the respective users of the application to have access to the dashboard or confidential information, users are required to log in to the application with their staff id/e-mail and password.

4.1.3. Authorization
A Role Based Access Control (RBAC) system is built into this application to ensure that only users with specific roles and permission can have access to protect resources or data.

4.1.4. Logging and Monitoring
Logging was built into the system to ensure that all errors or exceptions thrown during the use of the application are stored to enable the administrator to keep track of what is working and not working in the system. This application includes a monitoring feature that ensures that all actions carried out on the application and who was responsible for the action are logged into the database. This is done to ensure easy traceability in case of misconduct or falsification of data.

4.1.5. Database Backup and Recovery
To ensure accessibility and continuity of information, data are backed up either daily, weekly, or monthly. So, in case of data loss or the server is down, user data can easily be recovered and restored.

4.1.6. Rate Limiter
This module is used to ensure that no tenant is consuming the cloud resource by sending many requests to the server. Hence rate limiter module was configured to ensure that, at any point user of the system can only send 60 HTTP requests per second.

4.1.7. Encryption
Sensitive and highly confidential data, such as users' passwords, are not stored in plain text in the database but are encrypted with powerful algorithms.

5. Conclusion
Moving from a traditional paperwork system to an electronic document management system helps educational institutions to reduce costs, increase document security and minimize errors. A secured cloud-based electronic document management system provides users in the institution with a simple and efficient mechanism to store, access, manage, manipulate, synchronize and share their documents. It facilitates authentication to ensure that only authorized users gain access to services. Finally, archiving in the system is performed by saving the document as a PDF file into the file server. This functionality ensures data integrity and prevents data loss.

6. Acknowledgments

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