

Development of Secure Electronic Cybercrime Cases Database System for the Judiciary

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Abstract: The recent covid-19 pandemic created a barrier to every activity that needed physical interaction and involvement, especially in the judiciary. Careful research of some courts in Nigeria shown that case records are still been manually processed and stored and some courts operate a semi-digital and semi-manual processing pattern, which also has its own shortcoming of preprocessing manual records and converting them into digital records and physical presence is required to access court records. This research develops a secure electronic Cybercrime Cases Database System (eCCDBS), for prosecuted cybercrime in the judicial service in Nigeria. The system will provide an efficient method for collecting, retrieving, preserving, and management of court case records. The Rapid Application Development (RAD) methodology is used for the system development, because of its speed and time friendliness and can be easily restructured to meet the client's requirement at any point in time during the development life span. RAD can also present a prototype of the final system software to the client. Access control mechanism and secure password hashing were used to ensure the security of the system. The system was implemented and evaluated through deployment and found to have functioned according to the specification. The application subunits of records' creation, submission, modification, deletion, retrieval, and storage functioned effectively. Hence this system provides a secure online repository specifically for cybercrime case records that have elements of confidentiality, integrity and availability.

Index Terms: Electronic Cybercrime Record, Cybercrime Database System, Case Management System, Judiciary Cybercrime Database, Rapid Application Development, Cybercrime Cases Digitalization

1. Introduction

Manual recording was introduced into the justice system to facilitate the smooth running of activities in the court of law and it has without doubt served its purpose. But in recent times the manual record system has become obsolete and cumbersome task and has proved to be inefficient in handling and effectively track the ever-increasing crimes and the need for justice to those crimes and also the desire to see that for any crime, justice is served. In addition, the manually archiving of case record has been subjected to tempering, misplacement, misfiling and un-availability due to certain human, and natural factors, for instance worn out pages for some records, fading ink, dampness, rodents boring into record and the likes. Unfortunately, in Nigeria, most court still carry out their legal duties manually or semi digital and semi manual processing pattern. This is especially evident in court record management where case records are still been storage and processed manually. Hence this study is geared towards the development of secured database for prosecuted cybercrime records. This system will further revolutionize the judicial service by allowing court to securely store a well-structured record or records to an online database, which that will facilitate easy access of records, timely processing and organizing of record, and also support less human error factored in the manual process and spending involved in preserving records over a long period of time.

Alnieriute [1] states that traditionally, law and the legal system are associated with paper documents. The growth of corporate prosecutions and large-scale inquiries in the 1980s and 90s are thought to have prompted the use of computers in managing the volume of documents through cataloguing. Hence supporting the need to have a well secured digital repository. The research in [11] states that there is an increasing shift towards digitization and application of modern technological innovations by those appointed with the task of administering justice around the nations of the world, often targeted to further enhance efficiency and access to justice. Considering the study in [4] "the size of the databases, the expected transaction volumes, and the long-term value of the court records required a data manipulation system capable of providing high performance and integrity." It's an essential functionality that any database Management System must built to address. Database is core utility when designing any electronic system and

that will be exactly the reason the electronic cybercrime database will be introduced to the criminal justice, specifically for cybercrime cases that have been tried and judged by the court of law saddled with the power to handle cybercrime criminal cases in Nigeria.

The immediate beneficiaries of this proposed system include: the Judiciary, the Law enforcement agents, the researchers, and the public. The Judiciary will primarily use the system for documenting, collecting, submitting, storing of prosecuted case record that are computer or technologically related, and the retrieval of case data. The court will be able to interact with the database through a graphical user interface (GUI) where the submission, and modification of stored prosecuted case contents will be supported. Therefore eliminating: the time spent to access records; physical visit to a court building to access records; the incidence that are normally associated with the manual record keep such human errors, natural or man-made disaster (Covid-19, flood, earthquake, fire outbreak). Everything can be done remotely without one have to set feet to a court environment. The law enforcement agencies can easily store the evidence acquired during a case trial into the database. This will create a repository of evidence that the law enforcements might later want to fall back on in a later time when either revisiting a case or understanding legal procedures related to those prosecuted cybercrime case records. The system will be very useful for the researchers and academics for further research in this area to improve the system. Finally, the system will be useful to general public to have latest available information on cybercrime without having to submit any form of credentials.

The actual contribution of this project centers on the security provision for this electronic database application. The access control which controls the access of user to the application and prevent unauthorized users from using the system. The system is also designs with security architecture to respond to errors and thereby prevents the vulnerabilities of various forms. The system is implemented with website development software and consists front-end graphical user interface (GUI) and the backend database. The user interface enables user to perform creation, submission, modification, deletion, navigation of case records and view the case content with so much ease. The relational database management system which is MySQL allows storing case records in an organized format for easy manipulation, in other to achieve a rich composition and well-structured repository of cybercrime prosecuted case records. The user interface and the database interact together to ensure accurate results are returned from the database and accessed based on the user privileges. In addition, the system was tested and evaluated using some well approved web-based testing techniques, which boost the user confidence and trust to adopt the use of this system in court.

The remaining sections of this paper are organized as follows: The second part is a review of related studies; the third section is a discussion on the research methodology. The fourth section presents the result obtained and the fifth section bring to a close the research and gives future directions of potential study topics.

2. Related Work

Lageson [8] highlight the need of making the deliberate use of use online criminal court records for the sole purpose of carrying out research work, and maintaining individual privacy while making data available for both researchers and the general public. The paper posited there is a growing need to learn from cybercrime repository and draw some important lessons from those digitally store records in a database, in order to assist countries in their efforts to prevent and effectively prosecute cybercriminals. Alnieriute [1] examined the interaction and underlying normative tension between judicial values and growing dependency towards technological gadgets by the courts, and where those tools improve efficiency of the court's day to day operations, and offers a better solution to judicial transparency and accountability by opening them up to the world using various types approaches. Using six e-justice system examples, [11] designed and Implemented the e-Justice Systems. The system assists various interdisciplinary legal audience understand the impact of system design and design management principle of the system in increasing the success rate of access to justice.

Through this research, digitization of court paper records to electronic data has now opened up a focus where the availability of digital data could be used to train an ML program.

Although the quest, zeal and support needed to achieve full digitalization varies from court to court, state region, and countries, and how the judiciary in various jurisdiction across the world view the importance of information technology as regards to increasing the efficiency, transparency, accountability and the effect to the basic operations their courts such as the additional resource to hire or train professional, loss of jobs can be a contributing factors to lack of interest to the use of technology. There is a massive overload of knowledge now available at ones finger tips compared to the previous years. Ekpendu [5] recognizes the primary need of transferring legal based education, in achieving the administration of Justice in Nigeria; and agrees with [2] that the Nigerian judiciary should review all ICT enabling law to allow the full use of information and communication Technology (ICT) in courts. Salkute (2019) recommends that the need of the hour; is a court repository system that allows long-term preservation coupled with improving accessibility, availability, and efficient retrieval. And this can only be achieved by digital storage and system management.

The recent covid-19 pandemic has opened the eyes of the judicial body of some nations towards digitalization and information communication technology (ICT). Digital repository should be made available and accessible because it will ensure fairness in court [15], to maintain privacy of subjects [8], Improve the administration of justice, enhance its

quality and efficiency, and lower cost [9], Court employees or staff should be expert who knows both registry office and as well have computer skill that will ensure the smooth processing of digital records Wan Satirah Saman & Haider, (2017). Database is essential to achieving the collection and storage of court case record. For without storage there are no records to access. Hence Database design is required for the database development process that involves analysis of a problem definition by outlining the specifications and requirements, and provides all necessary tools and material for building a logical format of data [10]. The data in this case is the prosecuted cybercrime case records and managing the data software needs to be introduced. Poljak [13] in other to perform a comparative analysis on three relational database management system mentioned that database management system generally is software that enable easier work with databases, and this management software support the defining of database structure, retrieval of stored data, entering of data into the database and also processing stored data that have previously been submitted into the database.

Stored data or records need to be secured against tempering by malicious and not genuine persons by applying safety mechanism for on the database. Data confidentiality is a central component of many operating systems [12] since there is an exponential increase in sophistication and dependency on the World Wide Web (internet), there is a high demand and usage of internet based storage facilities, which has also upped the security risks associated to online data warehouse. [19] in a bid to tackle the security of user most personal information such as financial account information, medical records, maintained in a dynamic database system, proposed a secure in between access kind of security to protect user credentials when user is accessing their data and when also when data is not being accessed by the user. [16] discussed the importance of database encryption by reviewing of various database encryption techniques and in addition to the encryption mechanism. In relation to the literature in [16], [17] proposed the use of Secure Database Catalog to store the encrypted data of the users in database to protect the information in database. Encryption technique is simply the hiding meaning content from any untrusted third party and this is one of the most researched and used to secure databases. The implementation of this work however cannot be found.

The recent Covid-19 pandemic has changed the perspectives of most justice body across the globe, and have stirred them towards considering the digitalization their court processes and procedures. Countries such as Bangladesh are determined to shift to electronic judiciary to ensure access to justice for all of her citizens who are vulnerable and marginalized, to reduce the rate of delay in the court process and remove the backlog of cases Hasan & Rupa, (2021). India cries for the Indian judiciary to come out of the clutches of archaic ‘paper and records’ and embrace modern technology and also those technologies or applications introduced across the Indian judiciary should also be uniform [3]. Moreover, for countries like Nigeria and Malaysia, [18] outlines the various ICT-enabled applications engaged by this countries to aid decision-making in their respective courts, thereby promoting a shift away for manual or traditional legal practice. In another effort to improve use of ICT in judiciary, [7] reviewed the developed applications used by other jurisdictions in administering justice and concludes by the lessons drawn that the use of Information Communication Technology (ICT) in Nigerian courts will help boost the trust of the general public towards the court and also promotes access to justice while addressing the illiteracy, insecurity, corruption, lack of training and lack of access to justice.

3. Research Methodology and Goals

A. Research Methodology

The methodology employed in this research work include collection of judicial crime related data, analysis and design and use of Rapid Application Development (RAD) for the development of system’s application. Unlike the waterfall modal RAD minimizes the over planning stage by focusing prototype iterations. RAD allows client to see a demonstration copy of the final system software. This model is very fast and time friendly, can be easily restructured to meet client’s requirement at any point in time during the development and also because it is time sensitive. It contains four stages in its implementation: Analysis and Design, Rapid construction, Testing and Deployment. Rapid Application Development (RAD) is works with a well-defined business objective and well stated user group with easy features which makes its more effective enough to meet time constraint project.

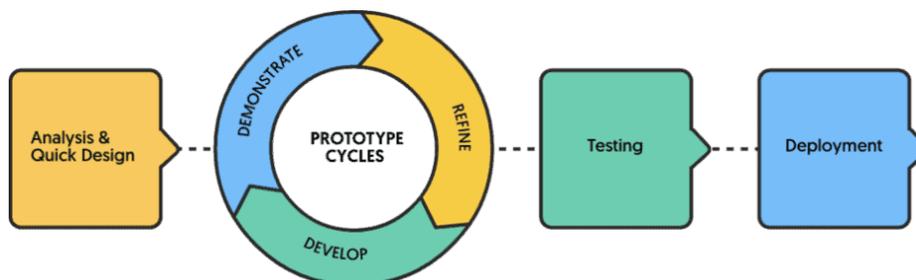


Fig. 1. RAD modeling life cycle

B. Research Goal

The goal of the research presented in this paper is to develop a secure electronic system that can be used to facilitate the business of cybercrime prosecution and dispensation of judgement with little or no stress. The system will facilitate easier storage, retrieval, and modification of the cybercrime records. The system used access control system to ensure the security of the proposed system.

4. Data Collection & Processing

A. Data Collection

The process of collecting information about existing systems, requirements and preferences using a formal technique such as interview, research, document examination and questionnaires. The face-to-face dialogue (interview), online exploration (research) and observation are the basic methods that were adopted in this work.

B. System Requirement

This is the software and hardware required for the design and development of this secure electronic cybercrime database management system. These requirements were being highlighted in table 1.

Table 1. Software and Hardware Specifications

S/N	Materials	Version
1.	Operating system	Window 10
2.	Random access memory (RAM)	1GB and above
3.	Central processing (CPU) speed	1.6 GHZ and above
4.	Hard disk drive (HDD)	50 igabyte

C. System Modeling

System models addresses concerns such as functionality, requirements, structure, security, reliability and other characteristics, thereby offering multiple views that make reasonable sense to client and stakeholders. In other to completely develop the system, the following conceptual models and structures were selected and used: Use Case Diagram, Class Diagram.

- System modelling using unified modeling language -Unified Modeling Language (UML) provides a well-established and widely recognized way of using a graphical notation to express ideas and visualize the design of a system software. The unified modeling language (UML) are of three (3) types, and they are: Structural, Behavioral, and Architectural Modeling.
- UML structural modeling -This type of modeling is used to show the different static aspects or objects in a system. The Class Diagrams is one of such structure. The class diagram is one form of structural modelling, which portrays a static structure of an application by displaying all classes contained in the application, its attributes, methods and connections among classes or objects are identified using Class Diagram. Relationships is simply the link that connects one class or group of class with another, while Attributes and Method simply identifies class unique qualities (characteristics) and its behavior respectively.

Fig. 2. represents the Class Diagram used in the design of this system. Fig. 3. represents the Use Case Diagram for Court Staff and Registrar, Fig. 4. represents Client and Registrar Diagram, while Fig. 5. depicts Chief Registrar Diagram.

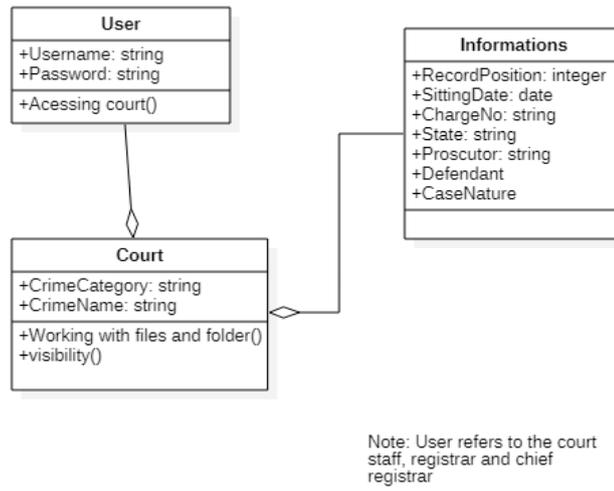


Fig. 2. Class Diagram

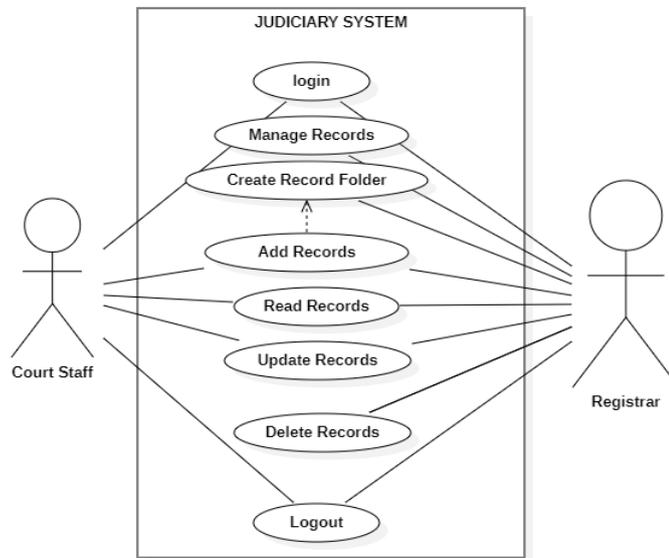


Fig. 3. Use Case Diagram for Court Staff and Registrar

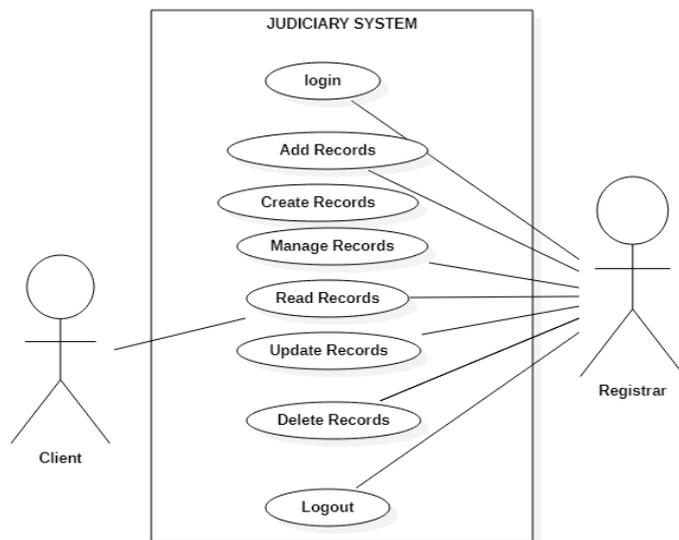


Fig. 4. Client and Registrar Diagram

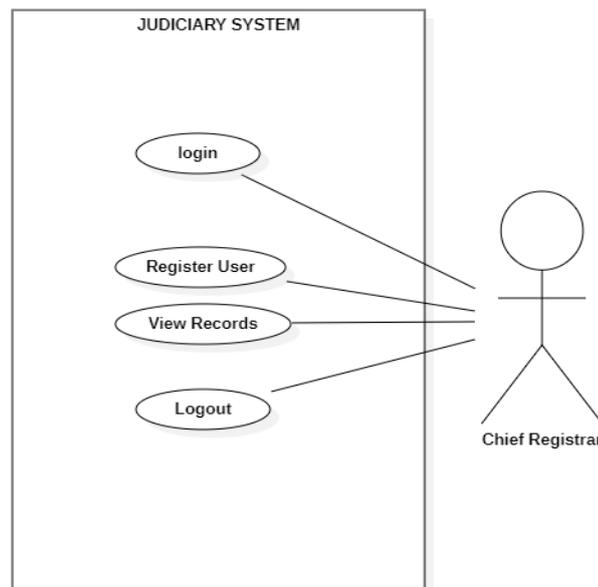


Fig. 5. Chief Registrar Diagram

D. System Implementation

This system was implemented using web-based software system: JavaScript cum PHP to design the front and backend for the application. The system allows the creation, collection, submission, modification, deletion and storage of cybercrime records that have been tried and prosecuted. The structure of the system is highlighted below:

- a. User Interfaces -User interface is a visual access points for users which support them, enabling users to interact with the designs. The interface is the crucial aspect which needs more attention. Some of the system functionalities of the project are shown below with the user interfaces.
 - i. Register User: The registration page allows the chief registrar to create a new user by assigning username and password to new users as shown in figure 6. The credentials will be used to authenticate and authorize a user.

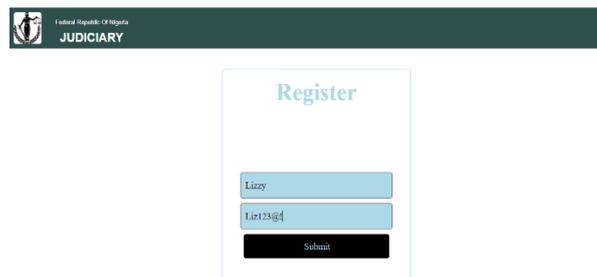


Fig. 6. Register User Page

- ii. Login Pages -The login pages are shown in fig. 7, 8 and 9. They are pages where system users enter their credentials for the system to authenticate and ensure only authorized users access the system providing a security standard to protect vital information. It login the users if correct credentials were entered while flags an error message if wrong credentials were submitted as shown in figure 10. The system has three login pages for the following users; the Chief Registrar who is un-identified as the super administrator, the court Registrar who can also be identified as the also an administrator, and the other for the, Court Assistant (court clerk) referred to as users.

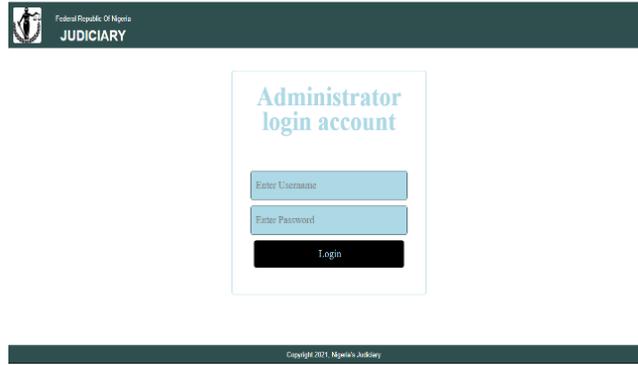


Fig. 7. Chief Registrar Login Area

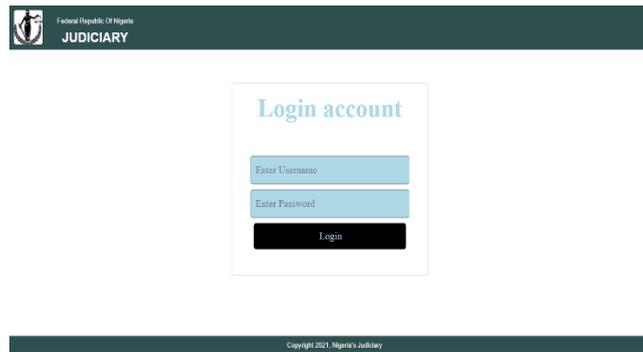


Fig. 8. Registrar Login Area

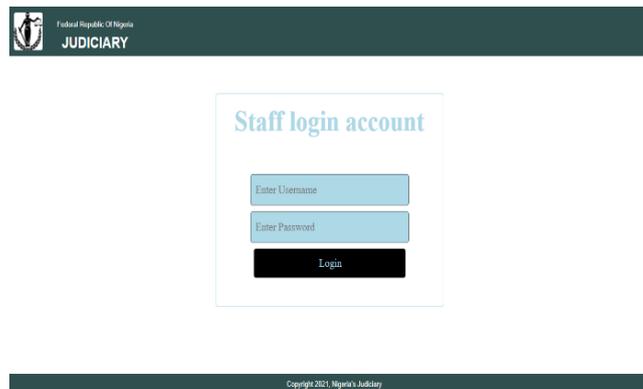


Fig. 9. Staff Login Area

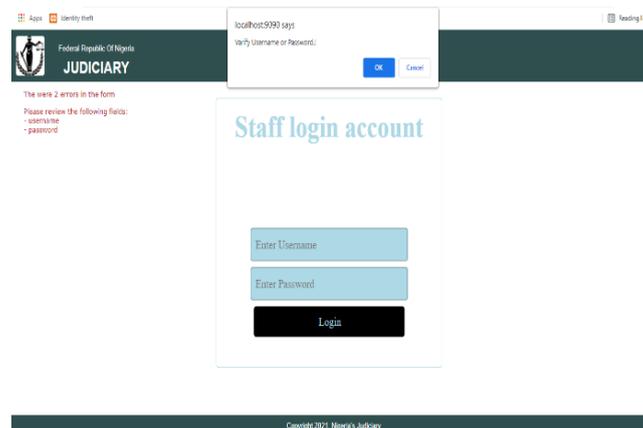


Fig. 10. Login Failed Security Feature

- iii. Home Page -After a successful login by chief registrar, registrar and court staffs. The home page for the respective users of the application shows up, where the users can carry out their individual functions by navigating through application by clicking on the labelled button or labelled links to proceed. Depending on the users privileges they can the following: registrar users, view cases (all records in database or single record), add records, edit record, delete records and also allow case record visibility to the public page (Folder or file). Each user has separate home page as shown in figures 11, 12 and 13.

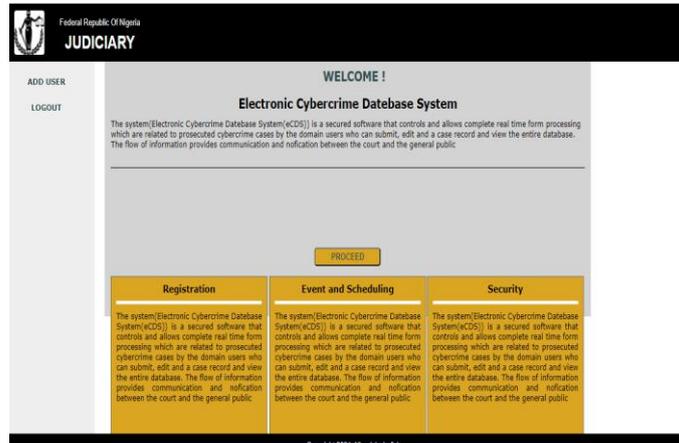


Fig. 11. Chief Registrar Home Page

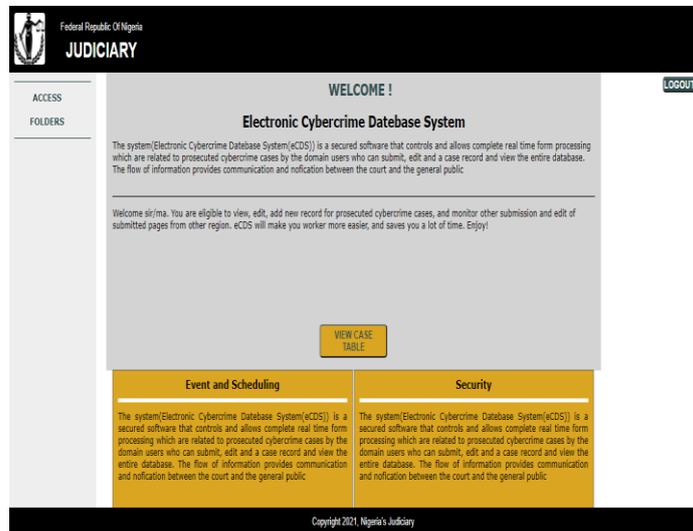


Fig. 12. Registrar Home Page

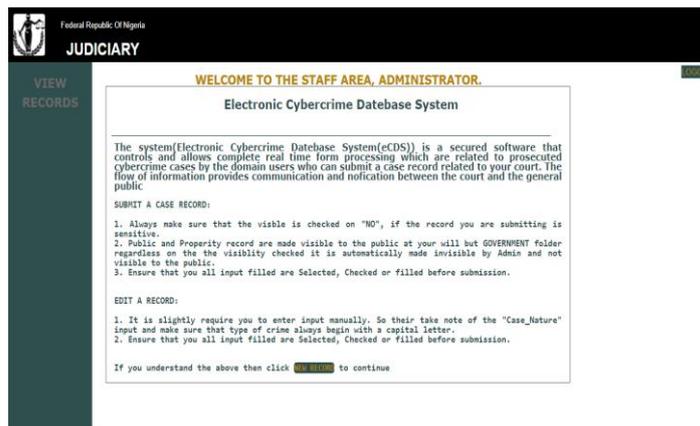


Fig. 13. Staff Home Page

- iv. **View Records and Search Function for Chief Registrar and Registrar,** The application has a feature that makes way easy for registrar to view all of the cases that are stored up in the database. There is a search button that allows searching for key words, and returns specified search as shown in figure 14. The application has a feature that makes way easy for registrar to view all of the cases that are stored up in the database, editing and deleting the records. There is a search button that allows searching for key words, and returns specified search as shown in figure 15.

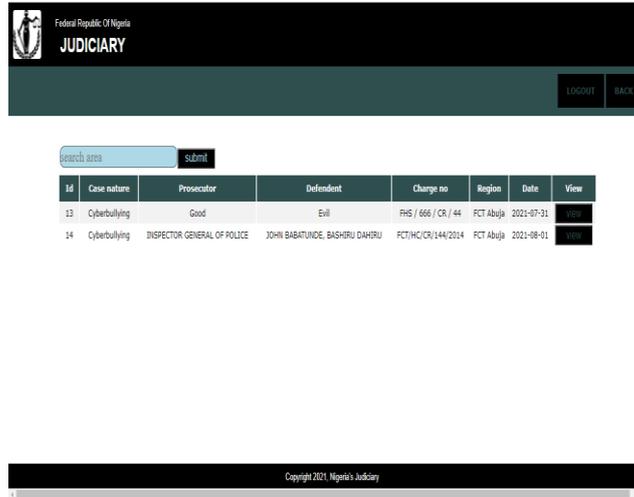


Fig. 14. Chief Registrar View Record

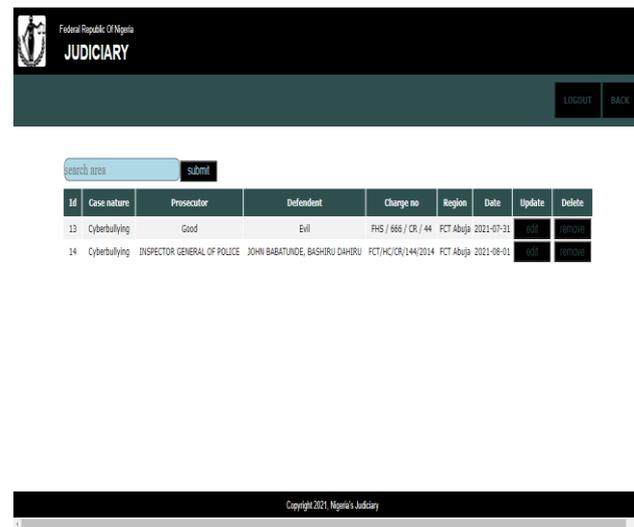


Fig. 15. Registrar View Record

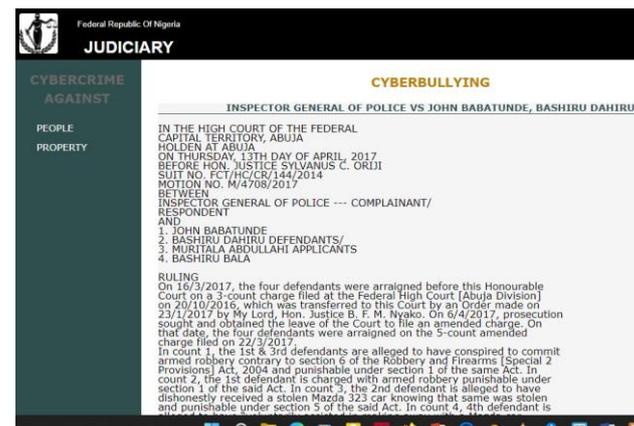


Fig. 16. Viewing Record

- v. Adding a Record -The application has a feature that makes it possible for new case record to be submitted to a selected folder in figure 17. After a successful submission a record is automatically incremented into the database, a mechanism that flag empty record submission shown in fig. 18.

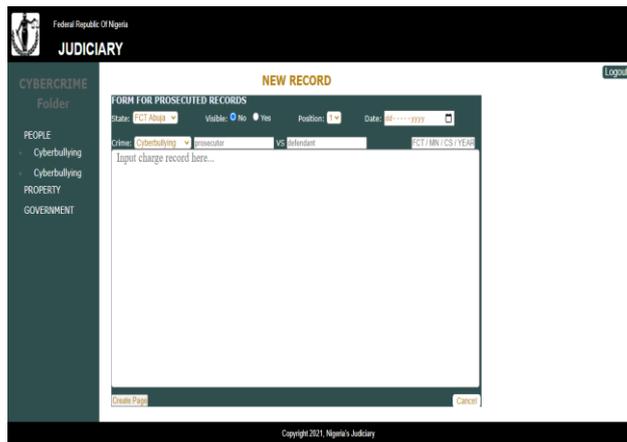


Fig. 17. Adding Record

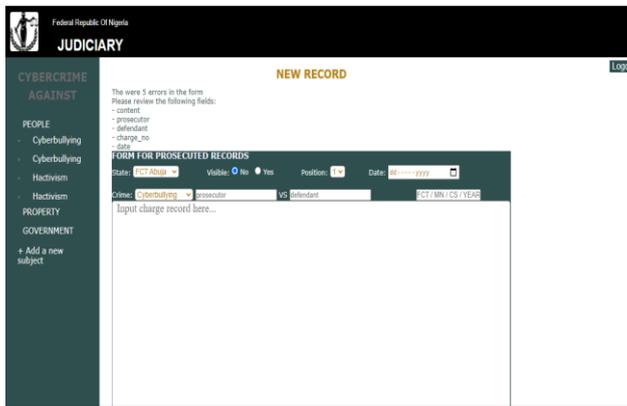


Fig. 18. Empty New Record Submission Alert

- vi. Editing a Record -The application has a feature in fig. 19 that makes it possible for submitted case records to be updated. Wrong spelling of prosecutor or defendant, incorrect charge number and content warrants updating to avoid storing incorrect record in the database.



Fig. 19. Editing Record

- vii. Adding and Creating a New Folder -The application allows the registrar to create a new folder that will hold lists of a particular category of cybercrime as shown in fig. 20 and 21.



Fig. 20. Adding a New Case Folder

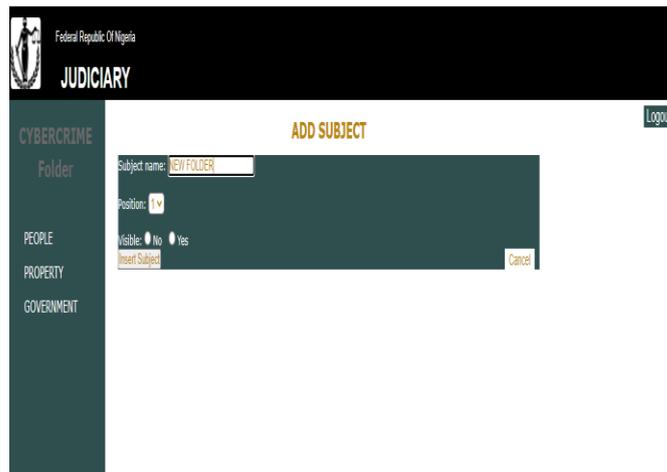


Fig. 21. Creating a New Case Folder

- viii. **Editing Folder** -The application allows the registrar to edit already created folder that holds lists of a particular type of cybercrime. Fig. 22. Is showing an editing a case folder.

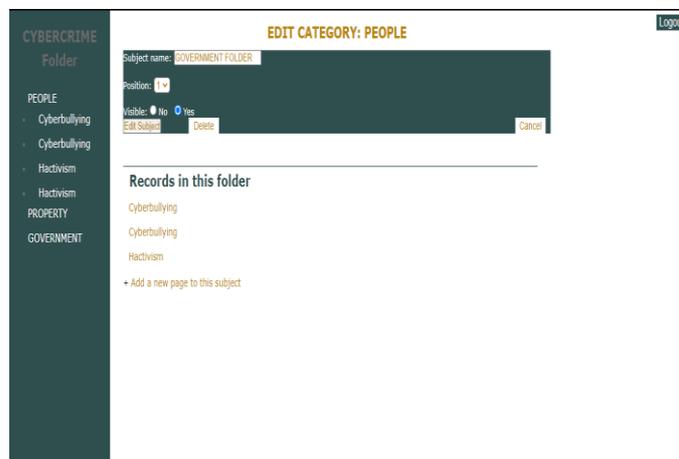


Fig. 22. Editing a Case Folder

- ix. **Online Public Webpage** -The online webpage enable clients to be able to visit the court and get last information by using the navigating to the “**About**” to know more about the site and the judiciary, the “**Contact**” to drop comments or reach out to the admin, and the “**News**” section to get latest knows and also access to available records without need for authorization and authentication credentials. And from this home page the court staff and Registrar will be redirect to their home page when the login in

with their credentials. Fig. 23 and 24 showing the home page and new page for the webpage respectively.

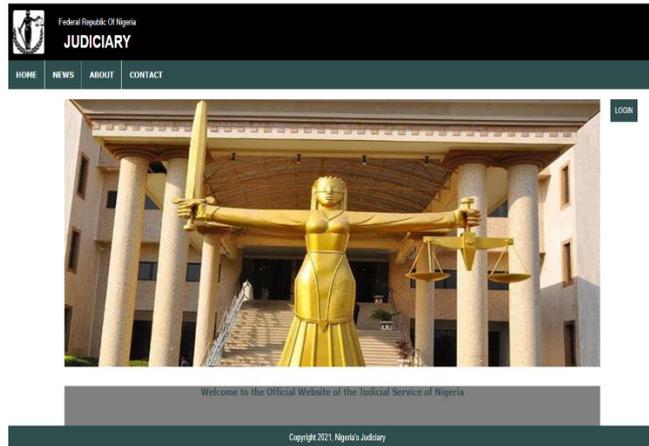


Fig. 23. Home Page



Fig. 24. News Page

5. Evaluation

A. System Testing

The application is tested to ensure that the system produces the required output to a given input. Testing determines if the system is able to execute complete actions in relation to its function and non-functional requirement. During the software test and implementation, the software as a whole is tested to ensure that all system components function well with each other, otherwise the application cannot be considered done. In other to make sure that the system is without error, the application was thoroughly executed to find out if the system behaves according to design by using the following types of web-based testing methods such as the unit, usability, integration, and functionality testing. Table 2 presents the system evaluation using different testing techniques. Unit testing, Usability, Integration testing, and Functional testing are used to evaluate the new application. The results show the system works according to specification.

Table 2. System Evaluation

Testing Phase	Tested Module	Expected Behaviour	Observation
Unit testing	The login pages	Authenticate user with correct credential and flag error when wrong credentials is used.	Meet specification
	The navigation menu	Navigation menu should redirect to correct page and menu visible and on remain on its position.	
	The home pages	Home page should be made visible	

Usability	The user direct apprehension or cognition.	Navigation, submit, edit, add or create buttons are recognized by the user as such.	Meet specification
	Content checking.	Content submitted is the same when retrieved.	
	Testing controls and navigation	All navigation and control did what users expects.	
Integration testing	User interface	Interface for clients should be visible	Meet specification
	Usability testing	User immediate cognation	
Functionality testing	Pages	Check to confirm that is no dead page	Meet specification
	Input	Perform negative testing to check for wrong inputs. Test to confirm the	
	Processes	Progress in work being done the by the system.	
	Validation	Checking all validations on each field.	
	Data integrity	Test to confirm the data integrity.	
	Redirect	Test to confirm that invalid redirects in the system do not exist.	

B. Discussion of Result

The developed application has provided an efficient of processing cybercrime crime case records and where those stored record are dynamic in nature and can be easily accessed online based on user (s) privileges. The application also encrypts user credentials such as password and username and has been able to perform the operation such creation, submission, modification, deletion, retrieval and proper storage of case record in a rational database. The system basic operation is presented in table 3.

Table 4. is used to present the features of the proposed eCCDBS system. The features include flexible submission and modification of records, availability, access control, and database presence, and encryption of the system. The digital process allows the submission and modification of documents at any location, while other systems are location-based. The documents are readily available on the digital process while the availability of document in other systems depend on several factors. The digital process involves access control which prevents unauthorized users from accessing the system. There is adequate database of records which make access easier at all time in the digitalized system while the manual system contains physical junks of records which are difficult to access. Table 5 presented the comparison of eCCDBS's features with existing related systems. The table shows proposed system has better features of availability and access control over existing ones. Access control ensures confidentiality and integrity of the documents while availability ensures the system can be used at all time.

Table 3. System Basic Operation

Operation	User /Action	Validation
Create	Chief registrar: The super admin creates the new users from his home page and credentials is secured by hashing algorithm.	User is created and can now use the system
Submit/upload	Court staff/court registrar: Court judgment is documented online and uploaded to the database	Cybercrime Records are stored.
Update	Court staff/court registrar: Record is edited and the new updated vision re-uploaded to the database	Updated record replaces the old record.
Delete	Court registrar: Record is permanently removed when no longer needed or not stored in the right format.	Record is removed
Retrieval/access	Chief registrar /court registrar/user: the stored record is made accessible anywhere over the internet	Record can be accessed based on the user privileges.

C. The Existing and Proposed System Comparison

The current system is compared with the existing court management system in terms of security and accessibility, in other to establish reasons the proposed system is preferable. The justification of the proposed system is presented in table 4 using the underlined features for validation. The features for comparison are include accessibility, availability, authorization, and online-based.

- i. Location-based – Is access to software certain, regardless of a person’s current location or time of the day? The submission is possible at anytime only in the proposed digital process while it is impossible in other manual and digital virtual process.
- ii. Availability – Is the court record always available for user view? The record is available only during work hours for manual / computerized existing system and available at all time for digital process while not available for the rest at all time.
- iii. Access control – is the court record accessed based on user privileges, hence ensuring confidentiality and integrity of any stored record? There is access control for digital system and physical manual / computerized system while absence for the rest.
- iv. Database – Is court case record is stored manually or on an online relational database? The database is available in all the system except manual / computerized system.

Tables 4. Features of Digital and Manual Judicial Record Systems

S/N	Features of Court Management System	Manual Computerized Process (physical presence) /	Manual Computerized Process /	Digital Process (virtual presence)	Digital Process
1.	Location-based (submission and modification)	No	No	No	Yes
2.	Availability	Yes, only during work hours	No	No	Yes, at all time
3.	Access control	Yes, only during work hours	No	No	Yes, at all time
4.	Database	Yes	No	Yes	Yes

Tables 5. Proposed eCCDBS with Existing Systems

S/N	Existing Judiciary Record Systems	Electronic Database	Availability	Access control
1.	Alnieriute, M. O. Z., & Ell, F. E. B. (2021) Aniekwe, C. A. (2019), Poljak, R., Pošćic, P., & Jakšić, D. (2017), Bharuka, D. (2020), Ekpendu, C. M. (2021), Ibekwe, C. S. (2021), Lageson, S. E. (2019), Lederer, F. I. (2021), Mousa, A., Karabatak, M., & Mustafa, T. (2020), Salkute, S. R. (2019), Singh, P., & Dr. Kuljit, K. (2016), Singh, S. P., Mishra, A. K., Maurya, A. K., & Tripathi, U. N. (2016), Valiant, G., & Valiant, P. (2020), Wan Satirah Saman, & Haider, A. (2017)	No database application, Only Study /Framework	-	-
2.	Buchanan, J. R., Fennell, R. D., & Samet, H. (1984)	Yes	No	No
3.	Lupo, G., & Bailey, J. (2014)	Yes	No	No
4.	Sule, I. (2021)	Yes	No	No
5.	Hasan, M. I., & Rupa, F. J. (2021)	Yes	No	No
6.	Proposed eCCDBS	Yes	Yes	Yes

6. Conclusion and Future Scope

The cybercrime cases database system was designed and developed in this research. The system allows prosecuted cybercrime records to be submitted into the database in a well-formatted manner. The system was designed using a secure architecture design. Use case diagram was used for the design with adequate attention to security consideration. The system allows court users such as the staff, registrar, chief registrar to perform creation, submission, modification, deletion, and enabling visibility of records or folder and view case records, based on their privileges level and also storing of court case records on a relational database. The flow of information provides a proper means of communication and notifications between the courts and the general public, in which the public can have access to relevant information that is made available by the court. This system was implemented and evaluated using RAD and system deployment and testing respectively. The system was found to work according to the specification and conforms to the standard in terms of Unit testing, Usability, Integration testing, and Functional testing. Table 5 presents the comparison of proposed eCCDBS with Existing Systems and shows the proposed system is preferable in terms of security of information in the database.

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