



Digital Archiving of Learner's Credentials Using Discrete Cosine Transform Algorithm

Leilanie Ann F. Francisco¹

¹Tario Lim National Memorial High School, Senior High School, 5707, Philippines

Email: leilannff@gmail.com¹

Abstract

Digital archiving has revolutionized the preservation and accessibility of handling different forms of data in the digital age. This study investigates the efficacy of storing and retrieving submitted documents using Full-Text Indexing and Boolean Search for searching and retrieval of documents uploaded and Discrete Cosine Transform (DCT) algorithm for the context of image compression evaluated using ISO 25010 standard and user acceptability test. Through a comparative analysis from a series of related studies, this research study identifies common challenges, innovative approaches and algorithms in digital archiving useful in automated storage and retrieval. Unified process model that includes use case diagram, sequence diagram and activity diagram were adapted for requirement analysis while black box testing and white box for testing operation. ISO 25010 standard and user acceptability test were utilized for system evaluation where respondents were chosen through purposive sampling technique. Respondents were the target end users with the participation of IT practitioners who are knowledgeable enough in system development and the system's full functionality. Results show that this study solves the underlying problems on storage and retrieval, thus limiting duplication of submitted documents. Findings highlight that functional suitability, reliability, portability, usability, performance efficiency, security, compatibility and maintainability of the system conforms to the ISO 25010 standard, easing the burden in handling documents submission and easily retrieving it.

Keywords: Archives; Digital Archiving; Discrete Cosine Transform Algorithm; Full-Text Indexing and Boolean Search; ISO 25010

1. Introduction

Digitalization is becoming the trend. Office transactions, bank transfers even file storage has totally transitioned from manual to automated. Files has become accessible anywhere, anytime and at any place. It has now become the norm as the technology advances. Offices and institutions, therefore, must know how to adapt from this transitioning to further improve its service delivery to its clientele. Learning how to adapt will also help increases productivity, not leaving any institutions behind. Schools are one of the institutions that should be adaptable to this change, making use of technology as a great tool to further enhance teaching and learning and at the same time ensure that learner's important documents are safe and properly stored. Learner's documents such as Form 137, PSA Birth Certificate, Certificate of Completion/ Graduation are significant piece of papers of the learners enrolled in secondary schools

under the Department of Education, thus, it should be handled with utmost importance and confidentiality. Recording, storing, and tracking of those should be taken into consideration to provide up-to-date reporting and asking for a duplicate copy of some documents which will also be used in another Grade level will be avoided. Public Secondary Schools face a problem with the record keeping of such documents thus causing another request to be made by the parent. Development and adaptation of a system that can provide up-to-date reporting and transparency of such prevalent problems in school is therefore a must to prevent such things from happening. Akinloye, et.al (2017) in their study Record Keeping Management Practices and Legal Issues in the School System states that the crucially, vitality and indispensability of records keeping and management cannot be overlooked in the school system to ensure the smooth

running of the school system as generated internal and external information assists school administrators in decision making process and is crucial in the improving the school's implementation of functional record keeping and information management system. Since records are the major tool in administration,[2] this therefore keeps the school system on the right path ensuring success in any school system. Moreover, to save costs and permits transparency, easy access, accountability and retrieval of the needed information, an effective and efficient record management system is a must. Legal basis, categories of record keeping and school system management's scope, phases and reasons for why the system is needed were examined in the study. It is then recommended that the school administrators and teachers must be deeply committed and professional enough to free school records from mutilation, easily identified and are kept in cabinet that is water aid or fireproof. With that in mind, Digital Archiving of Learner's Credentials using Discrete Cosine Transform Algorithm will help solve such existing problem in secondary schools where up-to-date tracking of documents submitted can be provided, thus, duplicate submission can be avoided.[1]

1.1 Statement of Objectives

This study aimed to develop a Web-based Digital Archiving of Learner's Credentials using Discrete Cosine Transform Algorithm for an effective storage of learner's credentials submitted.

Specifically, this study aimed to:

- To design and develop a system that will provide recording of the documents submitted by the learner.
- To design and develop a system that will easily track those documents submitted.
- Evaluate the system based on ISO 25010 and user acceptability test.

1.2 Conceptual Framework

The Conceptual Framework of the study is illustrated in Figure 1. It shows the input process and the output of the study. [5] The system will request the admin to input their account such as username, password. The administrator or the person authorized to access the system can input the learner's data and the credentials submitted. Those data and credentials will then be subject for archiving and easy retrieval once needed.

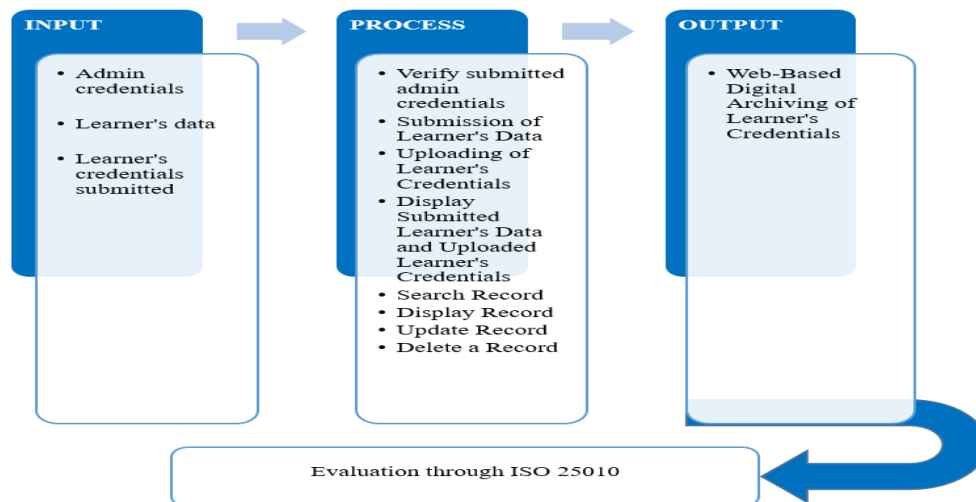


Figure 1.0 Conceptual Framework

Figure 1 Conceptual Framework

In managing updates, the admin or the person authorized to manage the system can update learner's data if there will be any correction, upload other credentials or delete a record. The output of the

study is the Web-Based Digital Archiving of Learner's Credentials using Discrete Cosine Transform Algorithm to be evaluated through ISO 25010.[3]

2. Method

This chapter includes the project description, requirement analysis, testing and evaluation of the study.[4]

2.1 Project Description and Development Process

Technological advancement has become the new norm in today's digital era. Innovations truly improve transactions and delivery of services. It helps ease and fast track requests from the end users. Institutions must therefore adapt to this change and maximize its positive impact. Digital Archiving of Learner's Credentials using Discrete[6] Cosine Transform Algorithm is a study that focuses on the development of a web-based application that will enable storage of learner's data and credentials submitted in order that duplication of submission will be avoided and at the same time easily retrieve those documents every time it is needed. The system administrator or the person authorized to manage the system will be able to digitally keep a record of the learner's data, retrieve those data and easily locate where the hard copy of those documents is located.[8] Updating and deleting learner's data will also be possible with the use of the system. The system interface is accessed through a Web browser by inputting the username and the password which when input correctly will lead to the main interface of the system where data and credentials of the learners are encoded and uploaded. Searching for the stored record is within the same interface. Figure 2 shows Prototyping Developing Business Model.[7]

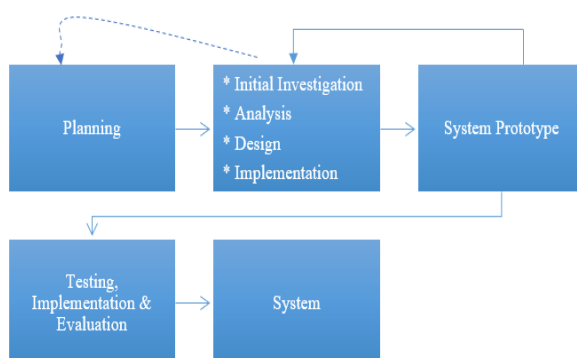


Figure 2. Prototyping Development Business Model

Figure 2 Prototyping Developing Business Model

The development of the system begins with the preliminary investigation done through interview and assessment of what the school needs. Taken into consideration the current existing problems.[9] The results then are used to analyze possible solutions, which leads to the design and implementation of the system prototype subject for Testing, Implementation and Evaluation before the System will be developed with full functionality. After the preliminary investigation is the analysis phase where how the proposed system can somehow solve the problem. Important factors are considered. So, are data and documents to be included.[10] The design phase begins with the development of its Graphical User Interface (GUI) taking into consideration the way the system will work. [11] Different pages, sections, tabs and features to ensure full functionality of the system are considered to ensure the required result are delivered.[12] During the development of the system, certain algorithms were applied to further enhance the functionality of the system, most especially on displaying the searching result which is the most important part of the system development. Full-text indexing and searching in Boolean mode has been adapted to speed up searches in MySQL. The following techniques and features have been applied to fully implement the searching algorithm: Indexing, as indexes allow the database to quickly locate the rows that match the conditions of the query; Primary Key and Unique Key Constraints to ensure that the values are unique in the indexed columns to speed up searches significantly as the database can stop searching once a matching row has been found; Full-text search, since Digital Archiving requires a large data to be stored,[13] full-text search capability of MySQL can efficiently return the searching result for text-heavy data; Query Optimization has also been put into consideration since SQL queries can greatly impact the speed of searches,[15] so does caching as proper configuration and utilization of caches can speed up frequently executed queries. Full-text indexing and searching in Boolean Mode has been adapted since one of the objectives of this study is to perform more advanced and flexible text-based searches. Full-text indexing was implemented by

creating a full-text index on a column for MySQL[16] to generate special index structure that allows to quickly search and retrieve relevant records based on text content while Searching on Boolean Mode was done by using Boolean operators and modifiers to construct search queries. To save space and in consideration of large image handling and processing, Discrete Cosine Transform Algorithm was utilized for image compression. It transforms a signal or image from its spatial domain (time or spatial coordinates) to its frequency domain (frequency coefficients). Image compression in DCT is implemented by partitioning the image, then the DCT will calculate the image, proceed to quantization, entropy coding the decompression, where the process is reversed. Using DCT offers certain advantages such as energy concentration that concentrate image information in a few low-frequency coefficients; compression efficiency to achieve high compression ratios while maintaining acceptable image quality for most practical purposes and standardization to ensure compatibility across different systems and applications In the implementation phase, it involves the functionality of the system, testing it to make sure it's error-free and delivered its desired result. It is in this phase where developers consider how the system works, debug errors and the system requirements. The developer makes sure that the end user will be well equipped on the how-to of the system. Evaluation conducted to make sure it meets the desired expectation and passed the standard based on ISO 25010.[18]

2.2 Requirement Analysis

The data and activity flow of the system used the Unified Process Model that includes the Use Case Diagram, Sequence Diagram and Activity Diagram. Also termed as Rational Unified Process (RUP) and the Open Unified Process (Open UP), the Unified Process model is used for object-oriented modeling which serves as a framework for software development. The process includes the following key features:

- It defines the order of phases.
- It is component-based, meaning a software system is built as a set of software
- components. For smooth communication,

- interfaces between the components must be well-defined.
- It follows an iterative, incremental,
- architecture-centric, and use-case driven
- approach.[19]

The Activity Diagram shown in Figure 3 shows how to access the system. There is only one user of the system to control fully the learner's data and credentials uploaded. Only authorized personnel can access the system by inputting the username and password. Updating login credentials is possible once inside the system. Once the admin or the authorized person is inside the system, he/she can now start inputting the learner's data and upload credentials submitted. The submitted data and credentials are stored in the database. It can be retrieved, updated or deleted. The system allows the display of newly added records automatically. Improvement of searching algorithm has been adapted with the use of keywords that even a single letter can now display a result. Filtering results were also adapted.[20]

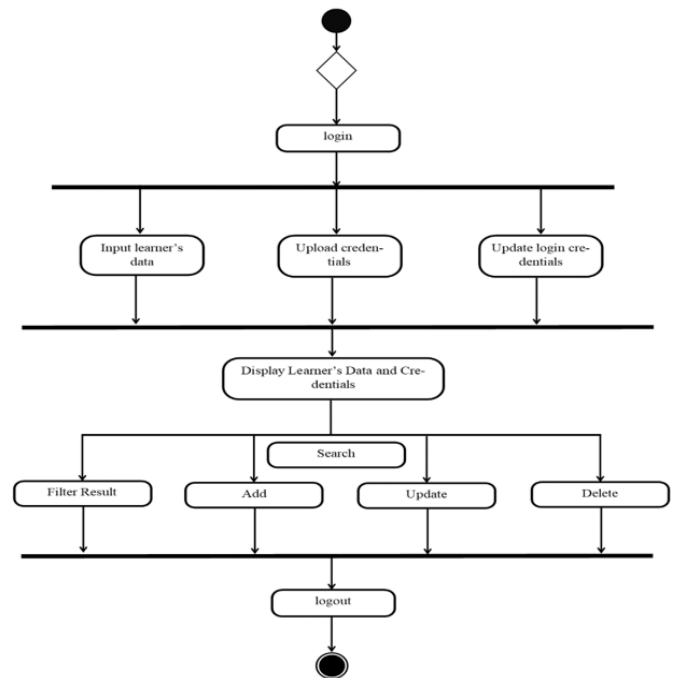


Figure 3.0 Activity Diagram of Digital Archiving of Learner's Credentials using Discrete Cosine Transform Algorithm

Figure 3 Activity Diagram to Access the System

The use case diagram is shown in Figure 4 Here, the admin is the only person who can access the system.[21] Login credentials are needed. The admin is also responsible for inputting the learner’s data, upload credentials and updating login credentials. Adding, Updating and Deleting of records can be done after searching for a certain record from the database. Storing and retrieval of records can be accessed by the admin as well.[22]

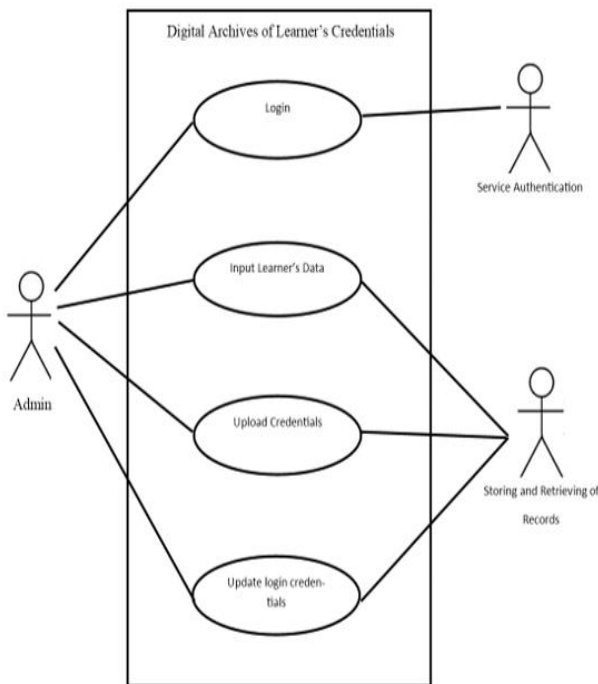


Figure 4.0 Use Case Diagram of Digital Archiving of Learner’s Credentials using Discrete Cosine Transform Algorithm

Figure 4 Use Case Diagram of Digital Archiving

A class diagram is a static model that shows the classes and the relationships among classes, which include both behaviors and states, with the relationships between classes. The class diagram is shown in Figure 5 It shows the utilization of data in this study. The admin will input the correct login credentials to be able to access the system. The admin of the system will then enter the learner’s data and archive the credentials submitted by the learners and will then manage what to do with those credentials.[23]

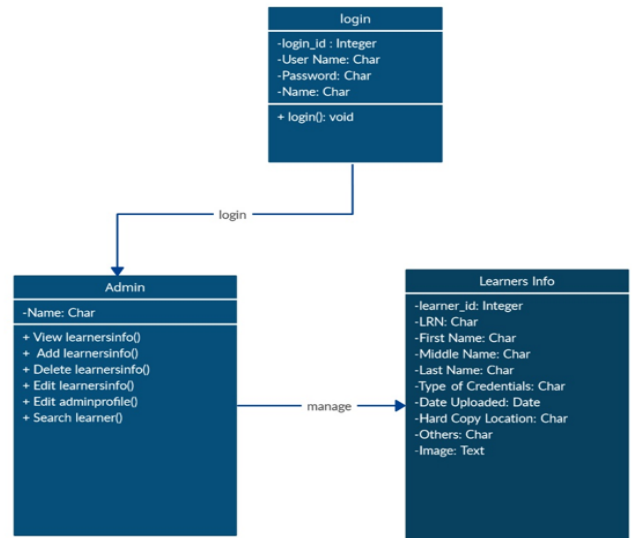


Figure 5.0 Class Diagram

Figure 5 Class Diagram

The sequence diagram is shown in Figure 6. The admin is required first to enter the login credentials before accessing the system. Once inside the system, the admin then can add and upload records. Once the data and credentials are stored in the database, records then can be updated and deleted. In cases where no records were found during the searching, an added feature is also available.[24]

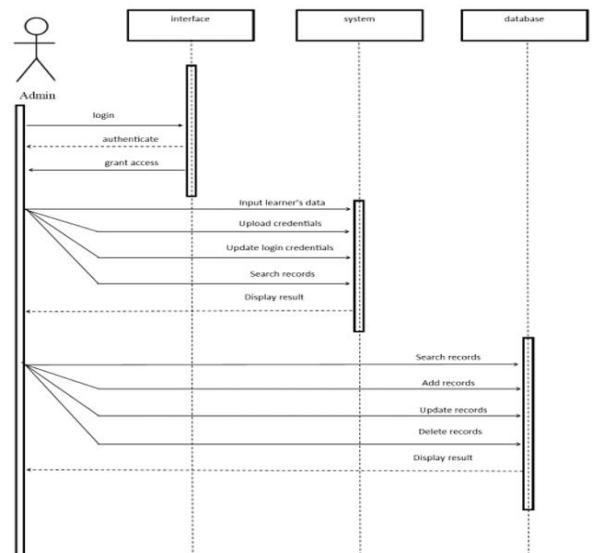


Figure 6.0 Sequence Diagram of Digital Archiving of Learner’s Credentials using Discrete Cosine Transform Algorithm

Figure 6 Sequence Diagram

2.3 Design Specification

This part of the study shows and discusses the Graphical user Interface of the System. It is what is being shown to the end user of the system which makes it easier for them to navigate and use. The administrator or the person-in charge enter the login credentials. Figure 7 shows logo page.[25]

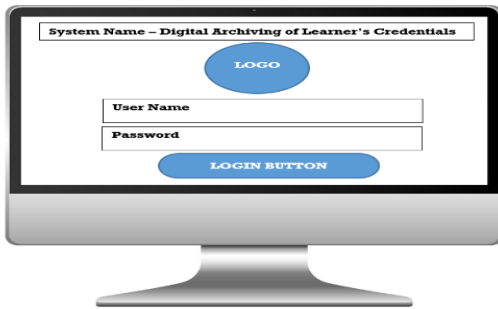


Figure 7.0 The login Page

Figure 7 Logo Page

Upon loading the system, the login page will be displayed where it will ask the user to input the username and password. School Images are displayed and the name of the system. Figure 8 shows the main page. [26]



Figure 7.1 The Main Page

Figure 8 Main page

In the main page, it is where uploading of learner's data and credentials to be uploaded is done. Search bar is present to easily search those records that are already stored in the database. Every time a new record is submitted, it will be displayed in the archived section. Figure 9 shows the search result page.[27]



Figure 7.2 The Search Result Page

Figure 9 Search Result Page

In the Search Result Page, it is where searching of records is done through keywords or combinations of letters and numbers. Once records are found, results will be displayed just like the image above. Figure 10 shows the display result page.[28]



Figure 7.3 The Display Result Page

Figure 10 Display Result Page



Figure 7.5 The Edit Profile Page

Figure 11 Edit Profile Page



To further secure the system, the admin can change the username and the password in the Edit Profile Page. Figure 11 shows the edit profile page.[29]

2.4 Testing and Operation

To test whether the system performs well and is in accordance with required specifications, the black box and white box testing is used. Black box testing is utilized as its primary focus in testing is concentrated on the over-all functionality of the system being tested. A software testing method that does not require knowledge on the internal structure of code or program. This testing mainly focuses on the checking on what functionality of the system is performing and what is not. Requirement Specifications documents can be used as a basis to start black box testing. Since there is no required programming knowledge, functional, behavior and close box testing is carried out under Black Box testing. To conduct the black box testing, the researcher invited the registrar-designate of the schools, the school head and some teachers to go through the system to test its functionality. The white box testing on the other hand is the software testing method in which internal structure is being known to tester who is going to test the software. Software developers usually utilize this testing type. Implementation and programming knowledge is required to carry out White Box Testing. Lower levels of testing such as unit and integration testing are applicable in this form of testing. The primary concentration of White Box Testing is on the testing of program code of the system under test like code structure, branches, conditions, loops etc. The main aim of White Box testing is to check on how the system is performing. Since programming knowledge is compulsory in this type of testing, structural, logic, path, loop and code coverage testing, open box testing is carried out. To conduct the white box testing, ICT Coordinators and Computer Teachers are invited to test the system. The respondents examine the GUI, the coding and the database structure of the system including the over-all technicalities of the system developed. [30]

System Evaluation

The Digital Archives of Learner's Credentials use ISO 25010 to evaluate the system. ISO is the software

product evaluation standard form the International Organization for Standardization. This international standard defines eight characteristics that describe software quality. ISO 25010 is the cornerstone of a product quality evaluation system. In evaluating the properties of a software developed, quality characteristics must be considered determined by the quality model. The evaluators of the system include the School Head, Registrar Designate which will act as the system administrator and teachers. In selecting respondents as evaluators of the system, purposive sampling was used. Since purposive sampling is a non-probability sampling method, the selected elements as sample are chosen based on researcher's sound judgment which results in time and cost efficiency. Rating system, Likert Scale that is widely used in questionnaires was adapted since it is designed to measure attitudes, opinions, or perceptions of the chosen respondents as subjects. Responses to a specific question or statement that include "strongly agree," "agree," "neutral," "disagree," and "strongly disagree" are a range of responses to which the subjects can choose from. Each category of responses are numerically coded, defining numerical values for that specific study, such as 1 = strongly agree, 2 = agree, and so on. Likert Scale were used to formulate questionnaire and rating sheet in evaluating the system's functionality and performance. A reliable statistical tool was used to evaluate the system as well. The mean will be computed from the result of the evaluation from the individual respondents.[31]

The formula for mean will be:

$$\text{Mean } () = F(X_n) / n$$

Where:

F = Frequency chosen by the respondents on the given X

X_n = Represents any of the numerical ratings

The evaluators of the system will be given an evaluation sheet with quality standards stipulated in ISO 25010. They shall answer each item based on the scale below. Table 1 shows the Likert scale.



Table 1 Likert Scale

MEAN	Description
4.21 – 5.00	Excellent
3.41 – 4.20	Very Good
2.61 – 3.40	Good
1.81 – 2.60	Fair
1.00 – 1.80	Poor

3. Results and Discussion

3.1 Development of the System

The web-based digital archiving system of Learner's Credentials using Discrete Cosine Transform Algorithm was designed and developed as stipulated in Design Specifications and made all the features fully functional.[32]

3.2 System Evaluation

To test if the system is acceptable and has meet its objectives, it was evaluated at Tario Lim National Memorial High School by the target users: the registrar-designate and class advisers who were selected based on purposive sampling method, including five (5) IT practitioners. The performance of the system was evaluated using ISO 25010 as to functional suitability, reliability, portability, usability, performance efficiency, security, compatibility and maintainability.[33] The registrar-designate who will be designated as the administrator of the system together with the teacher-advisers tested and evaluated the system with regards to its over-all functionality using a web-interface. The IT professionals, who are experts on the field and on how the system was developed, access the web-based interface as well but explored other important details of the system and how it works. Based on the above result of the study, the overall mean 4.82 with an interpretation of EXCELLENT shows that the system met its objectives and that its features and functionalities are in accordance with ISO 25010 Standard. As for the user acceptability test, the overall mean 4.95 with an interpretation of EXCELLENT proves that the system's features and functionalities were accepted by the target end users [35].

3.3 Summary of Results

The Web-based Digital Archiving System of

Learner's Credentials using Discrete Cosine Transform Algorithm helped the administration of the school as well as the teacher-adviser to limit multiple or duplication submission of credentials needed for enrollment. The system also served as a digital repository for those documents for easy retrieval. The administrator was able to input learner's data, upload credentials, and store and retrieve those credentials every time it is needed. The administrator has control of the system. The study has successfully developed a system that can store and easily retrieved learner's credentials using full-text indexing and searching in Boolean mode which was implemented by creating a full-text index on a column for MySQL to generate special index structure that allows quick search and retrieval of relevant records based on text content. Discrete Cosine Transform Algorithm has been adapted for handling image compression. The system was evaluated using the ISO 25010 standard by 30 evaluators composed of the registrar-designate and teacher-advisers with five (5) IT practitioners. The result of the evaluation shows that the functional suitability, reliability, portability, usability, performance efficiency, security, compatibility and maintainability conform to the standard of ISO 25010. Unique Key Constraints to ensure that the values are unique in the indexed columns to speed up searches significantly as the database can stop searching once a matching row has been found; Full-text search, since Digital Archiving requires a large data to be stored, full-text search capability of MySQL can efficiently return the searching result for text-heavy data; Query Optimization has also been put into consideration since SQL queries can greatly impact the speed of searches, so does caching as proper configuration and utilization of caches can speed up frequently executed queries. Full-text indexing and searching in Boolean Mode has been adapted since one of the objectives of this study is to perform more advanced and flexible text-based searches. Full-text indexing was implemented by creating a full-text index on a column for MySQL to generate special index structure that allows to quickly search and retrieve relevant records based on text content while Searching on Boolean Mode was done



by using Boolean operators and modifiers to construct search queries. Table 2 shows the Result of Evaluation using ISO 25010 Standard Table 3 shows the Result of User Acceptability Test.

Table 2 Result of Evaluation using ISO 25010 Standard

Characteristics	Result	Interpretation
Functional Suitability		
Functional Completeness	4.80	Excellent
Functional Correctness	4.80	Excellent
Functional Appropriateness	4.80	Excellent
Reliability		
Maturity	4.80	Excellent
Availability	4.80	Excellent
Fault Tolerance	4.80	Excellent
Recoverability	4.80	Excellent
Portability		
Adaptability	4.80	Excellent
Install ability	4.80	Excellent
Replace ability	4.80	Excellent
Usability		
Appropriateness Recognizability	5.00	Excellent
Learnability	5.00	Excellent
Operability	5.00	Excellent
User Error Protection	4.800	Excellent
Accessibility	4.80	Excellent
Performance Efficiency		
Time Behaviour	4.80	Excellent
Resource Utilization	4.80	Excellent
Capacity	4.80	Excellent
Security		
Confidentiality	4.80	Excellent
Integrity	4.80	Excellent
Non-repudiation	4.80	Excellent
Accountability	4.80	Excellent
Authenticity	4.80	Excellent
Compatibility		
Co-existence	4.80	Excellent
Interoperability	4.80	Excellent
Maintainability		
Modularity	4.80	Excellent
Reusability	4.80	Excellent
Analyzability	4.80	Excellent
Modifiability	4.80	Excellent
Testability	4.80	Excellent
Overall Mean	4.82	Excellent



Table 3 Result of User Acceptability Test

Characteristics	Result	Interpretation
Functional Suitability		
Functional Completeness	4.96	Excellent
Functional Correctness	4.92	Excellent
Functional Appropriateness	4.96	Excellent
Usability		
Appropriateness Recognizability	4.88	Excellent
Learnability	4.96	Excellent
Operability	5.00	Excellent
User Error Protection	4.92	Excellent
Accessibility	4.96	Excellent
Overall Mean	4.95	Excellent

Conclusion

The following conclusions were derived on the result of the study:

- The system was able to store the learner's data, credentials uploaded, name of
- credential including the hard copy location of the learner's credentials.
- The web-based system allows the
- administrator and teacher-adviser to view the submitted credentials and easily
- retrieve those if the need arises.
- The system was evaluated using ISO 25010 standard and user acceptability test. The overall[34]
- rating for user acceptability test and ISO 25010 is 4.95 and 4.82 respectively, with an interpretation of Excellent. This result shows that system design and development is in accordance with the standard of ISO 25010.

Acknowledgements

A worthwhile fulfilling journey, that's how I described the accomplishment of this study. Big thanks to all the people who without doubt extended their support and guidance. First and foremost, to our Almighty Father, for His infinite wisdom, strength and guidance all throughout the journey of finishing this study. To my adviser, Dr. May Florence Franco for her expertise and suggestions that really helped

improve both the system and the documentation. To the members of the panelist for their expertise To my family and friends, for their motivation, support and undying encouragement that really helped me keep going. You guys are heaven sent. My sincere appreciation for your act of kindness. May God bless you more abundantly. Digital Archiving requires a large data to be stored, full-text search capability of MySQL can efficiently return The registrar-designate who will be designated as the administrator of the system together with the teacher-advisers tested and evaluated the system with regards to its over-all.

References

- [1]. Haisam Abdel Malak, "What is Digital Archiving? Why is it Important?", [Online]. Available: <https://theecmconsultant.com/digital-archiving>. Written on January 4, 2023.
- [2]. "What are credentials?", [Online]. Available: <https://settlement.org/ontario/education/evaluate-my-credentials/credential-evaluation/what-are-credentials/>
- [3]. "Data Definition & Meaning", [Online]. Available: <https://www.britannica.com/dictionary/data>
- [4]. "Web Technology", [Online]. Available: <https://www.geeksforgeeks.org/web-technology/>
- [5]. Max, Nalsky. Flexible Workflow Automation



- System
- [6]. Saldon, M. (2015), "E-Document Tracking System", [Online]. Available: <https://www.semanticscholar.org/paper/E-Document-Tracking-System-Saldon/13314b30eed628daac9174e7c74012422a791ea6>
- [7]. Shahrul Nazmi and Bin Ismail, "Thesis Project Archive System (T-Pas)", [Online]. Available: <https://core.ac.uk/download/pdf/159183409.pdf>
- [8]. Xianghua Xiao, "Value Exploration and Application of Digital Archive Information Resources under the Information Ecological Environment – PMC", *J Environ Public Health*. 2022; 2022: 7135132, 2022 Sep 25.
- [9]. Jiban K. Pal and Falguni Pal, "(Pdf) Search Algorithms – An Aid to Information Retrieval in Digital Libraries", [Online]. Available: https://www.researchgate.net/publication/267702737_search_algorithms_an_aid_to_information_retrieval_in_digital_libraries, February 2007.
- [10]. S Oyama, A Wahana and R Widagsa, "A web-based e-archives information system design in Universitas PGRI Yogyakarta", *UPINCASE 2020 Journal of Physics: Conference Series* 1823 (2021) 012037 IOP Publishing doi:10.1088/1742-6596/1823/1/012037
- [11]. S. Antyoufeev, A. Nemov, A.G. Marchuk, and K. Fedorov, "Design and Implementation of Elec-tronic Archive of Documents", [Online]. Available: https://www.researchgate.net/publication/253203812_Design_and_Implementation_of_Electronic_Archive_of_Documents
- [12]. Jan Tomášek, "Design and implementation of Archival Storage component of OAIS Reference Model", Brno, Spring 2018.
- [13]. Emily Johnson, "Enhanced Retrieval Techniques for Digital Archives", Springer, 2019
- [14]. Michael Brown, "Scalable Indexing Solutions for Digital Archives with Boolean Search Support", ACM, 2018
- [15]. Jennifer Adams, "Optimizing Boolean Search Performance in Digital Archiving Systems", IEEE, 2020
- [16]. David Garcia, "Machine Learning Approaches for Intelligent Search in Digital Archives", Taylor & Francis, 2021
- [17]. Laura Martinez, "Semantic Search in Digital Archives: A Full-Text Indexing Approach", Wiley, 2020.
- [18]. [18] Mark Thompson, "User-Centric Design of Digital Archiving Systems: Incorporating Boolean Search Functionality", Springer, 2021
- [19]. Jessica Wong, "Advanced Techniques for Full-Text Indexing in Digital Archives", ACM, 2019
- [20]. Kevin Davis, "Enhancing Information Retrieval in Digital Archives: A Full-Text Indexing Approach", IEEE, 2018
- [21]. Sarah Lee, "Optimizing Query Processing in Digital Archives Using Boolean Indexing", Taylor & Francis, 2017
- [22]. Robert Johnson, "User Satisfaction and Usability of Boolean Search in Digital Archiving Systems", Wiley, 2022
- [23]. Jing Chen, Xiaoxiao Xu, and Wei Wang, "A Novel Image Compression Algorithm Based on Wavelet Transform and Discrete Cosine Transform", IEEE, 2018
- [24]. Muhammad Aamir, Muhammad U. Khan, and Saeed Anwar, "Real-Time Implementation of JPEG Image Compression Using Discrete Cosine Transform on FPGA", Springer, 2020
- [25]. Rajesh Kumar and Shailendra Tiwari, "Efficient Compression Techniques for Remote Sensing Images using Wavelet Transform and Discrete Cosine Transform", Springer, 2019
- [26]. Emily Zhang and Thomas Lee, "Application of Discrete Cosine Transform in Audio Signal Processing", Elsevier, 2015
- [27]. Jill Britton, "What Is ISO 25010?", [Online]. Available: <https://www.perforce.com/blog/qac/what-is-iso-25010>, May 6,



2021

- [28]. “ISO 25010”, [Online]. Available: <https://iso25000.com/index.php/en/iso-25000-standards/iso-25010>
- [29]. Ushna Ijaz, “What is a unified process model?”, [Online]. Available: <https://www.educative.io/answers/what-is-a-unified-process-model>
- [30]. Dennis, Alan, Wixom, Barbara Haley, & Tegarden, David (2010). Class Diagrams. Systems Analysis and Design with UML (3rd ed.), pp 213.
- [31]. “Difference between Black Box Testing and White Box Testing”, [Online].
- [32]. Available: <https://www.softwaretestingclass.com/difference-between-black-box-testing-and-white-box-testing/>
- [33]. “ISO 25010”, [Online]. Available: <https://iso25000.com/index.php/en/iso-25000-standards/iso-25010>
- [34]. “Purposive sampling”, [Online]. Available: <https://research-methodology.net/sampling-in-primary-data-collection/purposive-sampling/>
- [35]. “Likert scale”, [Online]. Available: <https://www.britannica.com/topic/Likert>.