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Automated Faculty Evaluation and Ranking System: Utilizing OCR, NER, and Decision Tree for a Web-Based Evaluation System



Abstract: - The Pamantasan ng Lungsod ng Maynila (PLM) a first and only chartered and autonomous university funded by a city government of Manila, faces challenges in faculty evaluation due to manual processes. Initially, the manual computation for faculty classification, ranking, and promotion result in errors and extended processing times. The manual faculty selection process is time-consuming and susceptible to human errors coupled with the absence of an automated decision support system makes it difficult for evaluators to streamline the faculty evaluation process. EduRate is a web-based application that utilizes machine learning, including Optical Character Recognition, Named Entity Recognition, and Decision Tree that automates the evaluation of faculty applicants, streamlining processes, improving workflow efficiency, and reducing administrative burdens. The researchers analyzed the data gathered using mean, utilizing the ISO/IEC 25010 standard. The participants were full-time and part-time faculty members from the College of Engineering (CoE) at PLM, selected using purposive sampling. Subsequently, applying Slovin's formula with a margin of error of 5% which was 97 respondents. Based on the summary of findings from a 5-point Likert scale, the research found that functional suitability (mean of 1.87), usability (mean of 1.60), reliability (mean of 1.86), security (mean of 1.81), and maintainability (mean of 1.89) were all rated as extremely to very effective. The research findings highlight the potential of EduRate to significantly enhance the quality of faculty evaluation and decision-making in hiring and promotion. Moreover, this can help institutions save resources, efficiently on evaluators' time, and transparent reports.

Keywords: Faculty Evaluation, Automated Decision Support System, Optical Character Recognition, Named Entity Recognition, Decision Tree

I. INTRODUCTION

A. Background

The Pamantasan ng Lungsod ng Maynila (PLM) holds a distinguished status in Manila, Philippines, founded in 1965 under Republic Act 4196. As the sole chartered and autonomous government-funded university, PLM aspires to lead in the city by providing exceptional instruction and research opportunities across various fields.[1]

Quality education stands as a cornerstone of PLM's mission, with the presence of a high-caliber faculty being a key component in achieving this goal. PLM recognizes the critical role that faculty members play in delivering quality education and ensuring positive student outcomes. As part of its commitment to academic excellence, PLM employs a rigorous ranking system to evaluate faculty applicants, considering factors such as qualifications, specialization, and alignment with PLM's goals and values.[2]

Prioritizing employee promotion and career advancement, especially in academic institutions, fosters a sense of care and support, leading to improved performance and increased employee confidence. However, research consistently emphasizes the critical role of educator competence and specialization in improving student learning outcomes, reinforcing the importance of selecting faculty members with the appropriate qualifications and expertise to deliver quality education at PLM.[3]

Decision-making in faculty selection is crucial[4], as evidenced by the Manual of Regulations for Private Higher Education (MORPHE) issued by the Philippines Commission on Higher Education. The MORPHE outlines faculty

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classification and ranking criteria, emphasizing the importance of academic qualifications, training, scholarly achievements, and teaching effectiveness. Faculty appointments are classified according to rank, with the parameters of ranking, classification, and promotion including educational qualification, scholarly achievements, teaching effectiveness, work experiences, and professional affiliations.[5]

The current process of faculty evaluation through the College Review and Ranking Committee (CRRC) Evaluation Form involves manual computation of weights for classification, ranking, and promotion. This manual approach may result in errors, and as the desired ranks increase, the process becomes lengthier due to the extensive verification of credentials. The IT chairperson highlights that the evaluation time is significant, and there is a risk of human error if credentials are not thoroughly verified during the evaluation process.

The inefficiencies in the current manual faculty selection process and manual computation for faculty classification, ranking, and promotion, characterized by time consumption and vulnerability to human errors, undermine PLM's goal of ensuring a robust and thorough faculty selection process. Additionally, the absence of an automated decision support system hampers PLM's capacity to streamline the evaluation of faculty candidates, particularly in a dynamic educational landscape.

B. Objectives

To address these challenges, this study aims to develop an automated faculty and ranking system called "EduRate," a web application that utilizes the following technologies:

- Optical Character Recognition (OCR): This will convert scanned or captured images of documents into machine-readable text.
- Named Entity Recognition (NER): This will extract key information from those documents.
- Decision Tree (DT) model: This will accurately categorize the documents into designated criteria for scoring and evaluation.

Moreover:

- The study will create an integrated system automating point calculation, candidate ranking, and eligibility verification.
- It will generate comprehensive reports, including the College Review and Ranking Committee Evaluation Form, Faculty Selection Board Evaluation Matrix Form, and Summary of Points necessary for PLM's recruitment or promotion process.

C. Scope

This study specifically focuses on PLM's faculty selection process, integrating OCR, NER, and Decision Tree along with the ISO/IEC 25010 software quality model for evaluation. The dataset includes scanned documents from previous applications and synthetic data. The research adheres to ethical guidelines concerning data privacy and confidentiality, particularly the Philippines' Data Privacy Act of 2012. The findings are context specific to Pamantasan ng Lungsod ng Maynila.

D. Delimitations

This study focuses exclusively on the faculty selection process at Pamantasan ng Lungsod ng Maynila (PLM), utilizing a dataset derived from scanned documents of past faculty applications and relevant university records. Notably, it incorporates machine learning technologies, decision support system principles, and the ISO/IEC 25010 software quality model for evaluation. However, it does not comprehensively explore all algorithms within these domains.

The automated system faces limitations, particularly in assessing Creative Works due to inherent subjectivity, a realm where human judgment remains essential. Ethically, the study adheres to data privacy guidelines, though broader ethical considerations are not extensively addressed. Findings are context-specific to PLM, offering reference value for similar institutions but with limited direct generalizability to other universities or educational systems, excluding hardware installations or broader evaluation criteria.

II. METHODOLOGY

The methodology for the development of EduRate involves extensive research to understand the specific needs and requirements of Pamantasan ng Lungsod ng Maynila's faculty evaluation process.

A. System Development

This section delves into the development methodology and design of EduRate web application.

1) Development Methodology

EduRate was developed using Agile Kanban [6], with six distinct stages:

Requirements: Information gathering and identification of necessary technologies.

Design: Planning and conceptualization using visual representations like Flow Charts and Use Case Diagrams.

Development: Development of the web application and implementation of machine learning algorithms.

Testing: Comprehensive assessment of the system using unit testing.

Deployment: Successful release of the web application to end-users with accompanying documentation.

Review: Final assessment using ISO/IEC 25010 to ensure the application met desired outcomes and system requirements.

The Agile methodology offers advantages aligned with the system's nature. Iterative development allows continuous refinement based on feedback and evolving needs, crucial for adapting to changing faculty evaluation criteria. Collaboration with stakeholders promotes understanding and meets university expectations. Early deliverables enable feedback, ensuring effective system development. Continuous testing ensures reliability, and the iterative approach mitigates risks. [7]

2) System Design

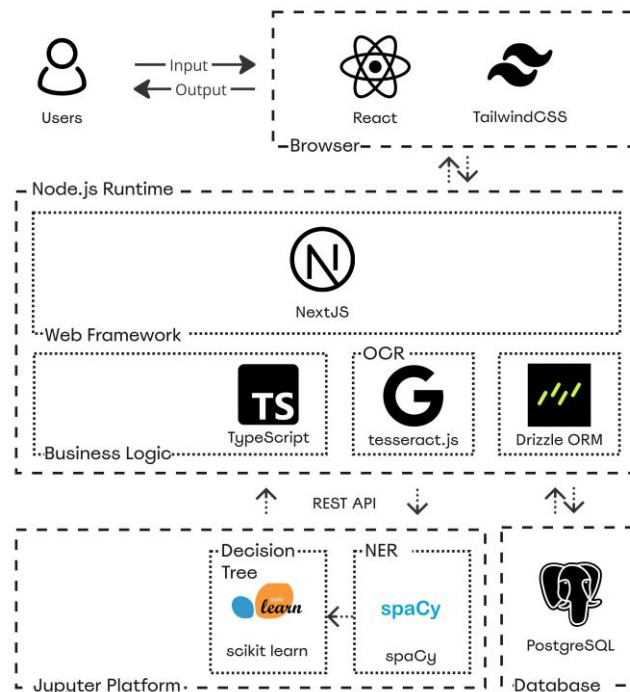


Fig 2.1: System Design

Figure 2.1 illustrates the system design of the Automated Faculty Evaluation and Ranking System, EduRate, designed to utilize NextJS for both frontend and backend components, ensuring an efficient and user-friendly platform.

Next.js, a React framework, is combined with Tailwind CSS to provide a visually consistent user interface, allowing seamless transitions between different sections of the application.

Node.js, coupled with TypeScript, forms the foundation for EduRate's business logic. This combination ensures server-side execution with strong typing to enhance code maintainability.

Drizzle serves as the Object-Relational Mapping (ORM) tool, interfacing seamlessly with the PostgreSQL database. This organized communication enhances the efficiency of data storage and retrieval.

For document processing, tesseract.js, a JavaScript library renowned for Optical Character Recognition (OCR), is employed to extract machine-readable data from uploaded documents.

Communication within the system is standardized through a REST API, utilizing the request package for efficient data and request exchange.

Jupyter Notebook functions as an interactive computing platform, supporting data exploration, analysis, and processing for both Named Entity Recognition (NER) and Decision Tree components, enhancing the system's analytical capabilities.

The integration of spaCy, a Natural Language Processing (NLP) library, facilitates Named Entity Recognition (NER), enabling the system to identify and categorize named entities within extracted text.

The Decision Tree model, implemented through Scikit-Learn, ensures autonomous and accurate categorization of uploaded documents, minimizing human intervention in the classification process.

B. Automation Development

This section delves into machine learning model's training and development for automation of EduRate web application.

1) Dataset Collection

To integrate the three machine learning models, preparation of the dataset is necessary. The dataset collection process for EduRate at PLM involves obtaining proper authorization, seeking approval from the university administration, and ensuring transparent communication and consent from previous faculty applicants. Emphasis is placed on strict adherence to data privacy and security protocols, including secure storage and encryption, to protect personal information.

The collected data comprises scanned faculty credentials and educational documents. This data undergoes rigorous cleaning to eliminate noise and irrelevant information.

To address the lack of data for training and diverse document requirements necessary to create a robust decision support system for faculty evaluation at PLM, custom datasets will be generated.

Synthetic data generation techniques will be employed to fill dataset gaps by creating additional data points based on observed patterns. This approach ensures the resulting model's robustness in handling various scenarios, even with a limited or incomplete original dataset.

2) Optical Character Recognition (OCR) Integration

Training Optical Character Recognition (OCR) is considered unnecessary, given that OCR engines are pre-trained. Specifically, we employ Tesseract.js. Tesseract.js encapsulates a WebAssembly port of the Tesseract OCR Engine, serving as a robust tool for character recognition and eliminating the need for additional training. OCR will convert the scanned or captured images of documents to machine-readable text.

3) Named Entity Recognition (NER) Training

Named Entity Recognition (NER) is trained to identify and extract specific entities from the document. These entities encompass various categories such as names, document types, dates, places, etc. NER plays a pivotal role in enabling the system to recognize and categorize different types of information. The output of NER will be in JSON format, providing a structured representation of the identified entities for further analysis and processing.

4) Decision Tree Training

The output generated by Named Entity Recognition (NER), formatted in JSON, functions as the input for the Decision Tree algorithm. This structured representation enables the Decision Tree to proficiently categorize documents for the evaluation process.

Utilizing predictions generated by the Decision Tree (DT) and adhering to the predefined evaluation criteria established by PLM, the system computes evaluation points for each faculty member. These evaluation points function as quantitative metrics to assess their qualifications and contributions, subsequently ranking individuals based on PLM's board matrix criteria. This systematic approach ensures an objective and standardized evaluation process, aligning with the predetermined benchmarks set by the institution.

C. *System Evaluation*

This section delves into evaluation and assessment of EduRate web application.

1) *Sampling Techniques*

In this study, researchers utilized purposive sampling to select study samples, focusing specifically on the College of Engineering faculty at PLM who possess credential documents. Simultaneously, simple random sampling was employed to obtain study samples, ensuring each respondent had an equal chance of selection. The researchers opted for Pamantasan ng Lungsod ng Maynila’s College of Engineering as the study locale.

To determine the number of samples, researchers applied Slovin’s formula with a margin of error set at 0.05 or 5%. The total number of faculty in the College of Engineering is 128. Consequently, the calculated number of respondents was 96.970, rounded 97. This systematic sampling approach ensures a representative and statistically significant dataset for the study.

2) *Basis for Evaluation*

The standard ISO/IEC 25010 is used to evaluate whether the system is of high quality. This standard defines some quality characteristics namely: functional suitability, usability, reliability, security, and maintainability.[8]

Functional Suitability: The system's accuracy in faculty evaluation and ranking is examined. Key features include OCR, NER, and Decision tree integration for credential extraction. The focus is on generating comprehensive reports and rankings, testing adaptability to different scenarios, and handling diverse faculty documents.

Usability: Evaluation centers on the user-friendliness of the web-based interface, particularly for faculty members and administrators. User feedback will be collected to identify areas for improvement in navigation and user experience.

Reliability: The system's reliability is assessed by analyzing its consistency in producing accurate evaluation points and rankings for faculty members. Testing involves real and synthetic data to measure stability and overall reliability.

Security: The system's security measures aim to protect data, prevent unauthorized access, and ensure confidentiality, integrity, and availability. Implementation includes encryption, access control, data integrity checks, compliance with security standards, and user education.

Maintainability: The evaluation focuses on how easily the system can be updated, modified, and extended. System’s code base and documentation to determine its maintainability and potential for future enhancements.

3) *Evaluation Metrics*

The study's respondents comprise faculty members who possess documents eligible for evaluation, considering various criteria and the volume of submitted credentials.

The survey tool employed for the evaluation process was a questionnaire designed in accordance with ISO/IEC 25010 standards. This survey was conducted among the faculty in the College of Engineering (CoE) during the final evaluation phase. Each respondent received a survey form, enabling the assessment of the overall effectiveness and impact of the Automated Faculty Evaluation and Ranking System or EduRate.

Table 2.1: Numerical Scale

Scale	Descriptive Rating
1	Strongly Agree
2	Agree
3	Neither Agree nor Disagree
4	Disagree
5	Strongly Disagree

To quantify the effectiveness and impact of the system, a 5-Point Likert scale (as illustrated in Table 2.1) was utilized.[9] This scale was specifically employed to measure the functional suitability, usability, reliability, security, and maintainability aspects of the Automated Faculty Evaluation and Ranking System.

Table 2.2: Effectiveness Scale

Scale	Numerical Rating	Interpretation
1	1.00 – 1.80	Extremely Effective
2	1.81 – 2.60	Very Effective
3	2.61 – 3.40	Effective
4	3.4 – 4.20	Somewhat Effective
5	4.21 – 5.00	Not Effective

Table 2.2 presents the numerical rating corresponding to the qualitative interpretation outlined in Table 2.1. The numerical ratings align with the following categories: Extremely Effective (1.00 to 1.80), Very Effective (1.81 to 2.60), Effective (2.61 to 3.40), Somewhat Effective (3.41 to 4.20), and Not Effective (4.21 to 5.00). These ratings were determined through a frequency distribution process.[10] The verbal interpretation adheres to the ISO/IEC 25010 model, ensuring a comprehensive and standardized assessment of the system's effectiveness.

III. RESULTS

The findings will be presented using tables to show the average scores for each main category and its subcategories from ISO/IEC 25010, including Functional Suitability, Usability, Reliability, Security and Maintainability.

A. Functional Suitability

Table 3.1: Functional Suitability Score of EduRate

Criteria	Mean	Interpretation
Completeness	1.79	Extremely Effective
Correctness	1.90	Very Effective
Appropriateness	1.93	Very Effective
Overall Mean	1.87	Very Effective

Table 3.1 summarizes the evaluation under the Functional Suitability categories.

Functional Completeness has a mean of 1.79, indicating that the system is Extremely Effective in terms of Completeness because during the time of evaluation, all specified tasks and user objectives were met.

Functional Correctness, on the other hand, has a mean of 1.90, indicating that the system is Very Effective in accuracy as the computed points are mostly correct.

The mean for Functional Appropriateness is 1.93, indicating that the system is Very Effective when adhering to existing standards and policies.

The overall mean is 1.87, which signifies that the system is Very Effective in terms of automated faculty evaluation and ranking system, providing the suitable functions that met the stated and implies needs of the respondents.

B. Usability

Table 3.2: Usability Score for EduRate

Criteria	Mean	Interpretation
Appropriateness Recognizability	1.45	Extremely Effective
Learnability	1.67	Extremely Effective
Operability	1.65	Extremely Effective
Use Error Protection	1.67	Extremely Effective
User Interface Aesthetics	1.59	Extremely Effective
Accessibility	1.60	Extremely Effective
Overall Mean	1.60	Extremely Effective

Table 3.2 summarizes the evaluation under the categories of Usability.

Appropriateness Recognizability has a mean of 1.45, indicating that the system is Extremely Effective at producing accurate findings for precise recognizability.

Learnability has a mean of 1.67, signifying its Extremely Effective due to the reduced effort required to learn the system.

Operability has a mean of 1.65, indicating the system's Extremely Effective as it offers features that make it easy to use.

Use Error Protection has a mean of 1.67, suggesting the system is Extremely Effective in protecting users from making mistakes.

User Interface Aesthetics has a mean of 1.59, implying that the system is Extremely Effective in providing pleasing and satisfying interaction for the user.

Accessibility has a mean of 1.60, indicating the system's Extremely Effective in allowing users with varying abilities to achieve specific goals in different contexts of use.

The overall mean is 1.60, demonstrating that the system is Extremely Effective in terms of usability providing a streamlined and intuitive interface for users.

C. *Reliability*

Table 3.3: Reliability Score for EduRate

Criteria	Mean	Interpretation
Maturity	1.82	Very Effective
Availability	1.93	Very Effective
Fault tolerance	1.87	Very Effective
Recoverability	1.81	Very Effective
Overall Mean	1.86	Very Effective

Table 3.3 summarizes the evaluation under the Reliability categories.

The system's Maturity has a mean of 1.82, indicating a Very Effective robust level of stability, consistency, and adherence to established practices.

Availability has a mean of 1.93, signifying its Very Effective implying minimal downtime and highlighting the system's capability to provide users with reliable and uninterrupted access, contributing to a positive user experience.

The mean for Fault tolerance is 1.87, indicating that the system is Very Effective in terms of handling unforeseen issues and maintaining system functional suitability even in the face of disruptions or errors.

The Recoverability mean is 1.81, suggesting that it is Very Effective implying that the system is well-prepared to restore normal operations swiftly and efficiently while ensuring users' data integrity.

The system's overall mean is 1.86, indicating that it is Very Effective in terms of being well-designed, resilient, and capable of delivering consistent and dependable services to its users in terms of reliability.

D. *Security*

Table 3.4: Security Score for EduRate

Criteria	Mean	Interpretation
Confidentiality	1.85	Very Effective
Integrity	1.86	Very Effective
Non-repudiation	1.77	Very Effective
Authenticity	1.77	Very Effective
Accountability	1.82	Very Effective
Overall Mean	1.81	Very Effective

Table 3.4 summarizes the evaluation under the Security categories.

Confidentiality has a mean of 1.85, indicating that it Very Effective at responding to and processing events quickly.

Integrity has a mean of 1.86, signifying its Very Effective in terms of efficiently utilizing information resources.

Non-repudiation has a mean of 1.77, indicating that the system is Very Effective in meeting system requirements. The Authenticity mean is 1.77, suggesting that it is Very Effective in terms of the integrity and reliability of the system's information.

Accountability has a mean of 1.82, indicating that the system is Very Effective when it comes to user ease of tracing an action.

The system's overall mean is 1.81, signifying that it is Very Effective in terms of security providing a secure environment for data and confidential information.

E. *Maintainability*

Table 3.5: Maintainability Score for Educate

Criteria	Mean	Interpretation
Modularity	1.72	Extremely Effective
Reusability	1.96	Very Effective
Analyzability	1.94	Very Effective
Modifiability	1.99	Very Effective
Testability	1.86	Very Effective
Overall Mean	1.89	Very Effective

Table 3.5 summarizes the evaluation under the Maintainability categories.

Modularity has a mean of 1.72, indicating that it is Extremely Effective at maintaining a well-organized and easily maintainable system architecture.

Reusability has a mean of 1.96, signifying its Very Effective in terms of maximizing the reuse of existing elements, promoting efficiency, and reducing redundancy in development efforts.

Analyzability has a mean of 1.94, indicating that the system is Very Effective in providing a high level of support for understanding and evaluating its internal structure and behavior, facilitating efficient maintenance and troubleshooting.

The Modifiability mean is 1.99, suggesting that it is Very Effective in terms of being highly adaptable and easily modifiable, allowing for swift and efficient adjustments to accommodate changes in requirements or technological advancements.

Testability has a mean of 1.86, indicating that the system is Very Effective when ensuring that modifications or enhancements can be rigorously validated and verified.

The system's overall mean is 1.89, signifying that it is Very Effective for easy maintenance, scalability, and resilience in the face of evolving requirements in terms of Maintainability.

IV. DISCUSSION

A. *Summary of Findings*

This study underwent testing in accordance with ISO/IEC 25010, designed to evaluate the caliber of software products. The 5 quality attributes in the ISO model were utilized to assess the software's level of effectiveness. The performance of the study, titled "EduRate: Automated Faculty Evaluation and Ranking System," is outlined below:

1. The web application was developed based on the study's objectives throughout the study, successfully addressing identified issues.
2. Testing all objectives involved applying ISO/IEC 25010 standards to evaluate functional suitability, usability, and security, with a sample size of 97 respondents. The calculated criteria yielded the following results:
 - a. Functional Suitability: Overall mean of 1.87, indicating the system's very effective functional suitability.
 - b. Usability: Overall mean of 1.60, signifying the system's extreme effectiveness in usability.
 - c. Reliability: Overall mean of 1.86, indicating the system's very effective reliability.
 - d. Security: Overall mean of 1.81, indicating the system's very effective security.
 - e. Maintainability: Overall mean of 1.89, indicating the system's very effective maintainability.

B. Conclusion

The study successfully addressed identified challenges through the development of the "EduRate" automated faculty evaluation and ranking system:

- Technologies employed in "EduRate" include Optical Character Recognition (OCR) for converting scanned documents into machine-readable text.
- Named Entity Recognition (NER) is utilized to extract key information from documents.
- The Decision Tree (DT) model was able to categorizes documents into designated criteria for scoring and evaluation.
- The integrated system automates point calculation, candidate ranking, and eligibility verification, streamlining the evaluation process.
- EduRate generates comprehensive reports, including the College Review and Ranking Committee Evaluation Form, Faculty Selection Board Evaluation Matrix Form, and Summary of Points, facilitating PLM's recruitment or promotion process.

C. Recommendations

The results of the comprehensive testing and evaluation of the system have yielded several key recommendations to augment its functionality and effectiveness.

- Researchers are strongly encouraged to delve into advanced machine learning techniques. This exploration aims to enhance the system's accuracy and efficiency, thereby contributing to its overall performance.
- A critical recommendation involves the prioritization of ongoing research into the latest security measures and privacy considerations. This emphasis ensures the system maintains robust safeguards for sensitive information, aligning seamlessly with contemporary cybersecurity standards.
- To address potential challenges related to scalability and performance, it is recommended to implement strategies for enhancing the system's scalability and optimizing its performance. This becomes particularly pivotal in anticipation of a growing user base or increased data volume.
- Another notable suggestion is the seamless integration of "EduRate" with existing academic systems. This integration serves the dual purpose of creating a harmonious workflow and ensuring compatibility with established institutional processes, streamlining overall operations.
- In addition, future researchers are advised to design the system with adaptability to evolving educational standards in mind. This forward-looking approach ensures the sustained relevance and effectiveness of the system over time, aligning it seamlessly with the dynamic nature of educational practices.

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