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Predictive Analytics in Human Resource with Machine Learning

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Abstract: This study aimed to develop a Predictive Analytics in Human Resource with Machine Learning System that integrates machine learning and data mining techniques to enhance recruitment and HR Management processes. Specifically, the system predicts the suitability of job applicants, where the target variable is the applicants qualification outcome, expressed as a classification (qualified or not qualified) and a corresponding qualification score used for ranking candidates based on their alignment with job requirements. At Madridejos Community College (MCC), many HR operations are still conducted manually, particularly in recruitment and applicant screening. HR personnel rely on paper-based records, manual document reviews, and basic file storage systems to manage applicant and employee data. These practices often lead to time-consuming evaluations, data inconsistencies, difficulty in tracking qualifications, delayed hiring decisions, and limited support for data-driven decision-making. Similar challenges are also experienced by many small and medium-sized institutions. To address these issues, the proposed system automates key HR functions, including applicant screening, interview scheduling, onboarding, and employee data management. It incorporates a predictive analytics engine and a Natural Language Processing (NLP) module to extract relevant feature such as skills, education, and work experience from resumes. These features serve as inputs to machine learning models, including Logistic Regression, Decision Tree, and Random Forest. The system was evaluated by the HR personnel, with an overall mean score of 4.15 (functional) which indicates that the system effectively performs its intended functions and high user acceptance, demonstrating its potential to improve recruitment efficiency and support data driven decision making in human resource management.

Keywords: Automation in Hr, Digital Transformation, Machine Learning, Human Resource Management, Recruitment HR analytics

I. INTRODUCTION

Human Resource Management (HRM) plays a vital role in organizational success by managing employee information, recruitment, performance evaluation, payroll, benefits, and workforce development. Among these functions, recruitment is one of the most critical yet often inefficient when handled manually. Effective HR practices enable organizations to attract, develop, and retain qualified personnel who contribute to productivity and long-term growth. However, many organizations particularly small and medium-sized institutions still rely on manual HR processes such as paper-based records and spreadsheets. In recruitment, these traditional methods result in highly inefficient applicant screening, where HR personal must manually review large volumes of resumes, leading to delays, inconsistent evaluations, and increased chances of human error. The lack of centralized systems makes it difficult to track applicant progress, compare qualifications objectively, and maintain accurate recruitment records. As a result, organizations experience longer hiring cycles, duplicated data entries, poor candidate matching, and delayed decision-making, which can negatively impact the quality of hires and overall organizational performance. Moreover, manual recruitment process limits the ability of HR personal to utilize data for strategic decision-making, reducing their capacity to identify top talent efficiently. Studies indicate that the adoption of digital HR technologies and analytics-driven systems significantly enhances recruitment efficiency, improves data accuracy, and supports evidence-based decision-making (Al-Faouri et al., 2024; Shiferaw & Birbirsa, 2025). Recruitment is one of the HR functions that benefits significantly from digital transformation. Modern recruitment systems integrated with Human Resource Information Systems (HRIS), artificial intelligence, and analytics tools enable organizations to automate applicant screening, reduce time-to-hire, and improve the quality of hiring decisions. These technologies streamline recruitment processes by efficiently matching candidate profiles with job requirements and processing large volumes of applicant data (Khatoon, 2025; Arora et al., 2024). Centralized HR systems also enhance organizational performance by integrating employee data, digital records, and HR analytics. Such systems improve decision-making accuracy, reduce administrative workloads, and increase productivity by automating processes like employee profiling, recruitment tracking, and performance monitoring (Bindra et al., 2025; Al-Faouri et al., 2024). Recent studies emphasize that digital HR systems enhance organizational efficiency, agility, and data-driven decision-making, allowing HR professionals to shift from administrative tasks to more strategic roles such as workforce planning and talent development (Nikolaou, 2021; Manoharan, 2024; El Garem, 2026). Furthermore, HRIS and people analytics technologies centralize employee and applicant data, increase recruitment results and better connect HR strategies with company objectives by automating regular HR tasks and supporting predictive insights (Islam et al., 2025; Moussa et al., 2025). In addition, the integration of AI-driven tools in recruitment enhances efficiency and accuracy by enabling real-time analytics, automated decision support, and intelligent candidate matching (Bastida, 2025). These advancements provide HR professionals with real-time access to applicant information and actionable insights, enabling faster, more objective, and evidence-based hiring decisions while improving overall organizational performance. Despite these advancements, Madridejos Community College (MCC) still relies on manual HR and recruitment processes, including applicant screening and employee record management. These manual procedures create challenges in data retrieval, processing efficiency, and decision-making accuracy. The absence of an integrated HR system highlights the need for a digital solution that incorporates predictive analytics, machine learning, and data mining to improve HR operations within the institution. HR predictive analytics utilizes machine learning algorithms, statistical models, and historical HR data to forecast workforce outcomes such as employee turnover, performance, and recruitment success. Recent studies show that machine learning models—including random forests, gradient boosting, logistic regression, and neural networks—can effectively predict workforce trends and support proactive HR decision-making (Chhetri, 2024; Fukui et al., 2023; Talebi, 2025). In recruitment, data mining techniques are applied to resume parsing, candidate scoring, and matching applicants with job requirements. Machine learning plays a crucial role in enabling a more objective and consistent screening process by evaluating candidates based on quantifiable features such as skills, qualifications, and work experience rather than subjective human judgment. Unlike traditional manual screening, which is often prone to bias, inconsistency, and fatigue, machine learning models apply standardized criteria across all applicants, ensuring fairness and reducing the influence of personal preferences or unconscious bias. Classification and clustering algorithms further help identify patterns and key success factors among candidates, improving the accuracy of hiring decisions. Additionally, advanced analytics techniques, including spatial data analysis and data enrichment, support a deeper understanding of labor market trends and talent availability (Graczyk-Kucharska, 2023). Research on digital HRM implementation indicates that integrating analytics within HR systems improves efficiency, reduces administrative workload, and enhances overall HR service delivery (Mahmoud et al., 2025). However, scholars emphasize that predictive analytics should be embedded into HR processes rather than treated as a standalone tool. Despite its advantages, challenges remain in implementing HR predictive analytics, including data quality issues, potential algorithmic bias, and limited interpretability of complex models. To address these concerns, researchers recommend the use of explainable AI techniques—such as feature importance analysis and visualization tools—to ensure transparency, accountability, and trust among HR professionals (Talebi, 2025; Chhetri, 2024). Overall, current

research supports the use of predictive analytics in HR management while emphasizing the need for high-quality data, strong governance, and context-specific model development. These insights justify the development of a Predictive Analytics in Human Resource System with Machine Learning for Madridejos Community College to automate HR processes, centralize workforce data, and support more efficient and data-driven recruitment decisions

Objectives of the Study

This study aims to develop a Predictive Analytics in Human Resource with Machine Learning System Specifically, it aims to

1. Develop a system with the following features:
1.1 Applies machine learning and data mining techniques to predict and identify qualified candidates.
1.2 Support interview scheduling to ensure organized and timely candidate evaluation.
1.3 Facilitates appointment processing for selected candidates.
1.4 Manages employee onboarding activities to ensure a smooth transition into the organization.
2. To use McCall's Software Quality Model to assess the quality of the developed system.
3. To evaluate the Predictive Analytics in Human Resource System with Machine Learning Using Use Questionnaire, effectiveness, usability and user satisfaction.

Conceptual Framework of the Study

The conceptual framework of the Predictive Analytics in Human Resource System with Machine Learning presents the overall structure and flow of the system, illustrating how inputs are transformed through analytical processes to generate meaningful outputs and organizational outcomes. The framework serves as a guide for understanding how data-driven techniques are applied to support human resource management functions and improve decision-making. It emphasizes the role of predictive analytics in integrating recruitment, employee management, and workforce data into a centralized and intelligent HR system.

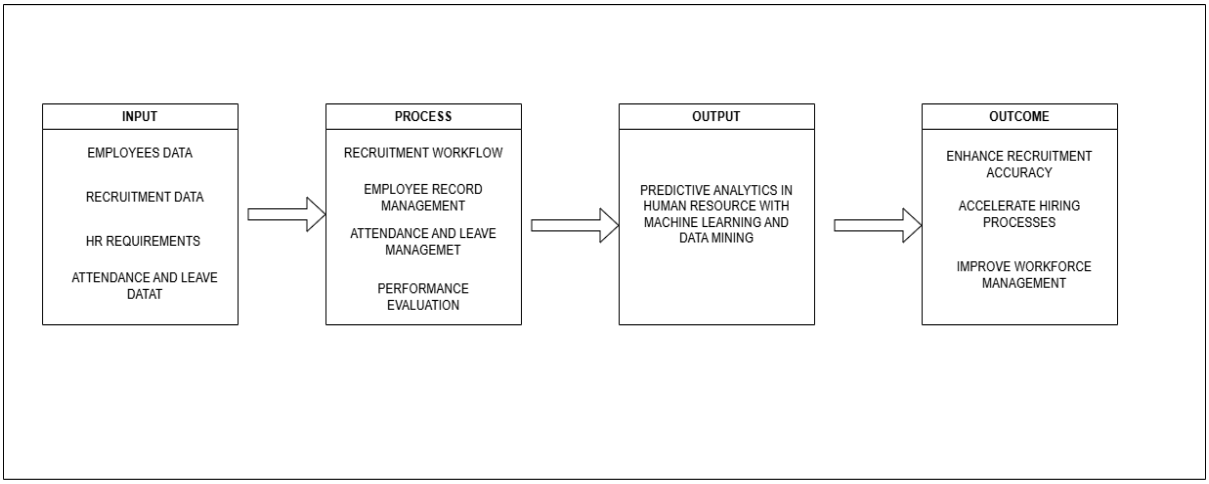

Figure 1. Conecptual Framework of the Study

Metholodogy

The study used descriptive and developmental research approach to analyze existing resource processes and identify inefficiencies in current HR and recruitment practices. Through this approach, the study examined the current workflow, data management methods, and operational challenges to determine system requirements and propose appropriate technological solutions.

SDLC Model

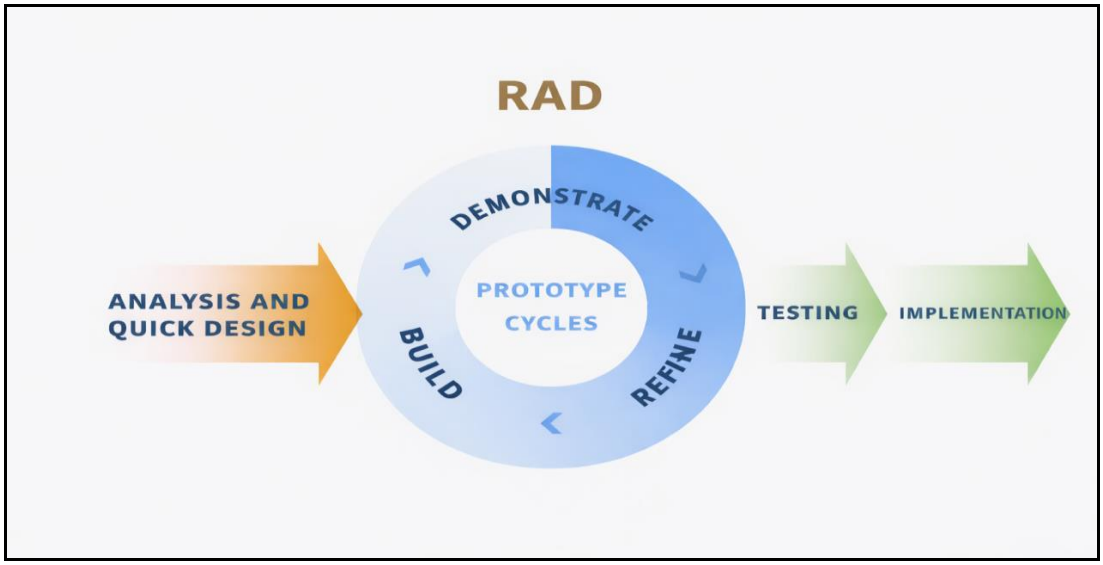

Figure 2. Rapid Application Development Model

The study used the Rapid Application Development (RAD) model as the Software Development Life Cycle (SDLC) framework to develop a Predictive Analytics in Human Resource with Machine Learning. RAD emphasizes rapid development, iterative prototyping, and strong user involvement, allowing system components to be built quickly and improved through continuous feedback from users. This approach enable the system to support HR functions such as recruitment management, employee performance monitoring, workforce analytics, and decisiosn-making. The analysis and quick design phase examined existing HR and recruitment processes through interviews, observation, and consultations with HR personnel and Staff. Key system requirements identified included automated applicant screeening, candidate ranking, employee data management, predictive recruitment analytics and HR performance monintoring. Initial system designs, such as database structures, workflows, and interface layouts, were created. The study was conducted at Madridejos Community College (MCC) in Cebu, Philippines, focusing on the Human Resource Office. A total of 33 respondents participated , including HR personnel , administrative staff, institutional staff, and IT experts who served as system users. Purposive sampling was use to select participants with relevant knowledge of HR process and digital systems.

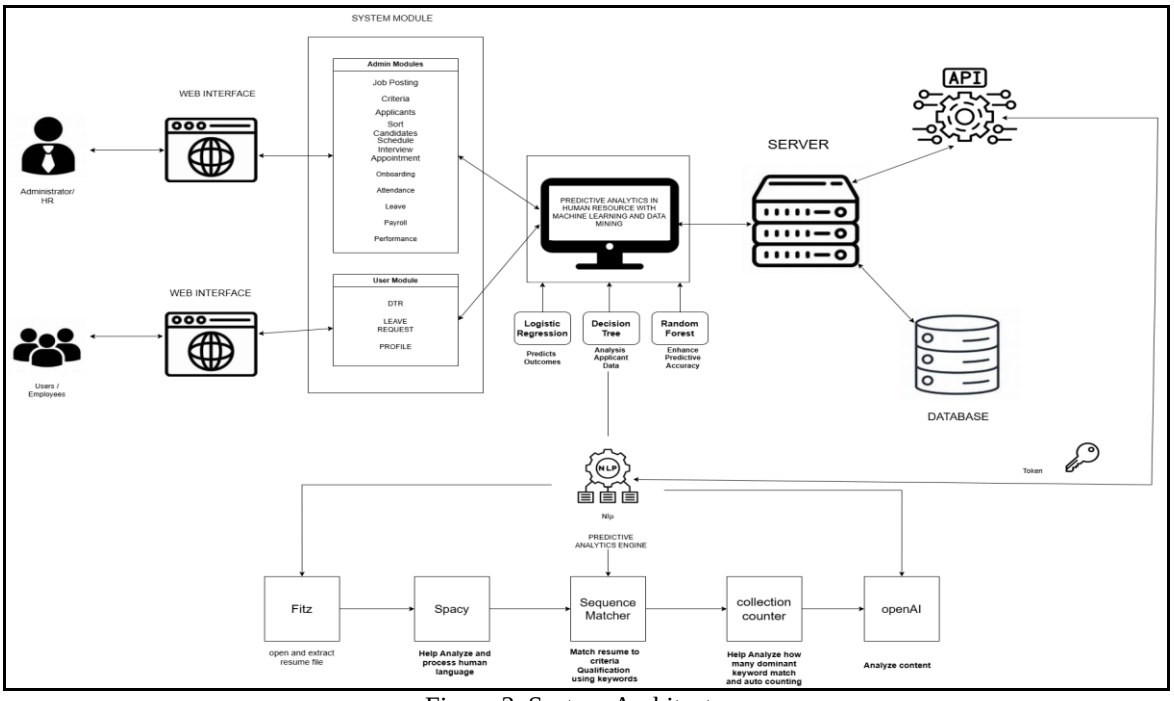

Figure 3. System Architecture

The system architecture consists of a web-based platform accessed by HR administrators and employees. Administrative modules manage job postings, applicant ranking, interviews, onboarding, attendance, payroll, and performance evaluations, while employees can manage profiles, leave requests, and daily time records. The system integrates Natural Language Processing (NLP) tools such as Fitz, SpaCy, and keyword matching to analyze data. It also embeds machine learning models such as Logistic Regression, Decision Tree, and Random Forest for predictive analytics. During the build phase, the system was developed as a web application using python-based frameworks with HTML, CSS, JavaScript, and Tailwind CSS for the interface. HR datasets and resume documents were used to train predictive models and support automated resume analytics. In the demonstration phase, the system prototype was presented to users for feedback on usability, workflow, and functionality. Suggestions from respondents were use to refine the system. The testing pahse involved expert evaluation to assess system functionality, reliability , and security, as well as usability testing testing with HR personnel and system users to determine ease of use and effieceincy. Finally, during the implementation phase, the system was deployed within the institution. HR staff were trained to use modules such as applicant management, resume screening, candidate ranking, and HR analytics dashboards. The RAD model contiunous system improvements as organizations needs evolve.

TABLE I. PREDICTIVE ANALYTICS IN HUMAN RESOURCE WITH MACHINE LEARNING AND DATA MINING

Customize Questionnaire		
Criteria	**Mean**	**Verbal Interpretation**
The system effectively utilizes predictive analytics in identifying qualified candidates	4.39	Strongly Functional
The system effectively applies machine learning and data mining technique to predict and identify qualified candidates.	4.11	Functional
The system helps improve the accuracy of the candidate selection decisions.	4.07	Functional
The interview scheduling feature helps ensure organized and timely candidate evaluations.	4.04	Functional
The system facilitates efficient appointment processing for selected candidate.	4.14	Functional
The onboarding module helps ensure a smooth transition of newly hired employees into the organization.	4.14	Functional
Total	4.15	Functional

TABLE III. MCCALLS' SOFTWARE QUALITY MODEL

McCall's Software Quality Model		
Criteria	**Mean**	**Verbal Interpretation**
Correctness	4.56	Very Good
Reliability	4.56	Very Good
Efficiency	4.64	Very Good
Integrity	4.56	Very Good
Usability	4.60	Very Good
Maintainability	4.78	Very Good
Flexibility	4.78	Very Good
Testability	4.44	Very Good
Portability	4.67	Very Good
Reusability	4.78	Very Good
Interoperability	4.56	Very Good
Total	4.63	Very Good

TABLE IIIII. USE QUESTIONNAIRE EVALUATION

Use Questionnaire Evaluation		
Criteria	**Mean**	**Verbal Interpretation**
Ease of Use	4.33	Strongly Agree
Ease of Learning	4.23	Strongly Agree
Satisfaction	4.34	Strongly Agree
Total	4.28	Strongly Agree

Results and Discussion

The evalution results demonstrate that the Predictive Analytics in Human Resource with Machine Learning System performs at a very high level across functionality, quality, and usability while significantly reducing reliance on traditional manual HR practices. Based on Table 1, the system achieved an overall mean score of 4.15 (Functional), indicating that respondents agree it effectively performs its intended HR management functions. The highest rating of 4.39 (Strongly Functional**)** was given to the system's ability to utilize predictive analytics in identifying qualified candidates, emphasizing its critical role in improving recruitment decisions. This strong performance is supported by the integration of predictive models such as Logistic Regression, Decision Tree, and Random Forest, which analyze both historical and real-time applicant data to generate accurate predictions of candidate suitability. These models enable the system to classify applicants, estimate hiring probabilities, and enhance the reliability and objectivity of decision-making. A significant contribution of the system is its ability to minimize and eliminate several manual HR processes that are traditionally time-consuming and prone to error. Tasks such as manual resume screening, where HR personnel individually review large volumes of applications, are replaced by automated filtering based on predefined criteria and predictive scores. Similarly, subjective candidate evaluation and ranking are transformed into objective, data-driven processes, reducing bias and inconsistency in hiring decisions. The system also removes the need for manual comparison of applicants, as it automatically generates ranked results and predictive insights. In addition, paper-based and spreadsheet-based tracking systems are replaced with a centralized digital database, eliminating data redundancy, encoding errors, and difficulties in record retrieval. Administrative tasks such as manual interview scheduling, appointment processing, and employee onboarding are also streamlined through automation, reducing workload and ensuring faster, more organized recruitment workflows. Other system features, including machine learning and data mining for candidate prediction (4.11), improvement of selection accuracy (4.07), interview scheduling (4.04), appointment processing (4.14), and employee onboarding (4.14), were all rated Functional. Overall, these results confirm that the system not only enhances predictive decision-making but also streamlines and automates the entire recruitment process, replacing inefficient manual practices with an intelligent, data-driven HR management approach. The system obtained an overall mean score of 4.63 (Very Good), indicating high software quality and strong adherence to established standards based on McCall's Software Quality Model. Under Product Operation, it received Very Good ratings in correctness, reliability, efficiency, integrity, and usability, demonstrating accurate outputs, consistent performance, efficient resource utilization, secure data handling, and user-friendly design. For Product Revision, maintainability and flexibility achieved the highest scores, indicating that the system can be easily modified and improved, particularly in updating predictive models and analytics components, while testability also rated highly. In terms of Product Transition, portability, reusability, and interoperability were all rated Very Good, confirming that the system can operate across different environments, be reused for other applications, and integrate seamlessly with external platforms. The modular design also supports the reuse of predictive models and visualization components for future scalability. The system was evaluated very positively in terms of usability, achieving an overall mean score of 4.28 (Strongly Agree) across usefulness, ease of use, ease of learning, and satisfaction. Respondents found the system effective in improving work efficiency, easy to understand and operate, and highly satisfying in terms of performance and reliability. The integration of visual analytics and trend-based graphical outputs further enhances user experience by making complex predictive data more accessible and easier to interpret. Overall, the consistently strong evaluation results validate the system's effectiveness and reinforce the claim that the integration of predictive analytics models (Logistic Regression, Decision Tree, and Random Forest), combined with data visualization and predicted trend line analysis, significantly improves recruitment efficiency, accuracy of candidate selection, and strategic HR decision-making. The system is therefore highly reliable, user-friendly, and ready for deployment, with strong potential for continuous improvement and future expansion in intelligent HR analytics.

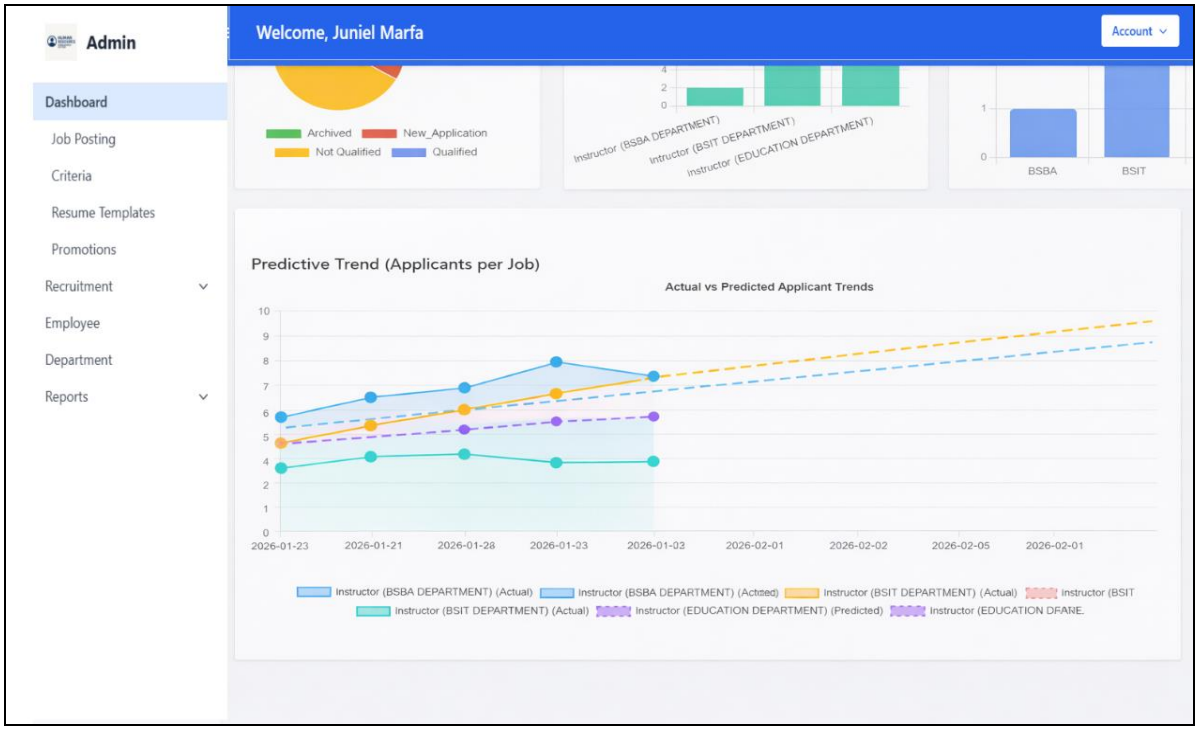

Figure 4. Predictive Trend Line Visualization

Figure 4 The graph presents both actual and predicted applicant trends for instructor positions across three departments: BSBA, BSIT, and Education. The solid lines represent actual applicant data, while the dashed lines indicate the predicted trend based on historical patterns. For the BSBA Department, the actual data (blue solid line) shows a consistent upward trend, increasing from approximately 6 applicants to a peak of around 8 before slightly declining. The predicted trend (blue dashed line), however, continues to rise steadily, suggesting that the number of applicants is expected to increase further in the coming periods. This indicates strong and growing interest in BSBA positions.

In the BSIT Department, the actual data (orange solid line) also demonstrates a steady increase in applicants over time. The predicted trend (orange dashed line) shows a more pronounced upward trajectory compared to the actual data, indicating that the system forecasts a significant increase in future applicants. This suggests that BSIT positions may experience higher demand and should prepare for increased recruitment activity. For the Education Department, the actual data (teal solid line) remains relatively stable with slight fluctuations, indicating a consistent but lower number of applicants compared to the other departments. The predicted trend (purple dashed line), however, shows a gradual upward movement, suggesting a potential increase in applicant interest over time, although at a slower rate.

Overall, the comparison between actual and predicted lines reveals that all departments are expected to experience positive growth in applicant numbers, with BSIT showing the strongest projected increase, followed by BSBA, while Education shows moderate growth. The predictive trend lines highlight the system's capability to forecast future recruitment patterns, enabling HR personnel to anticipate demand, allocate resources effectively, and improve hiring strategies.

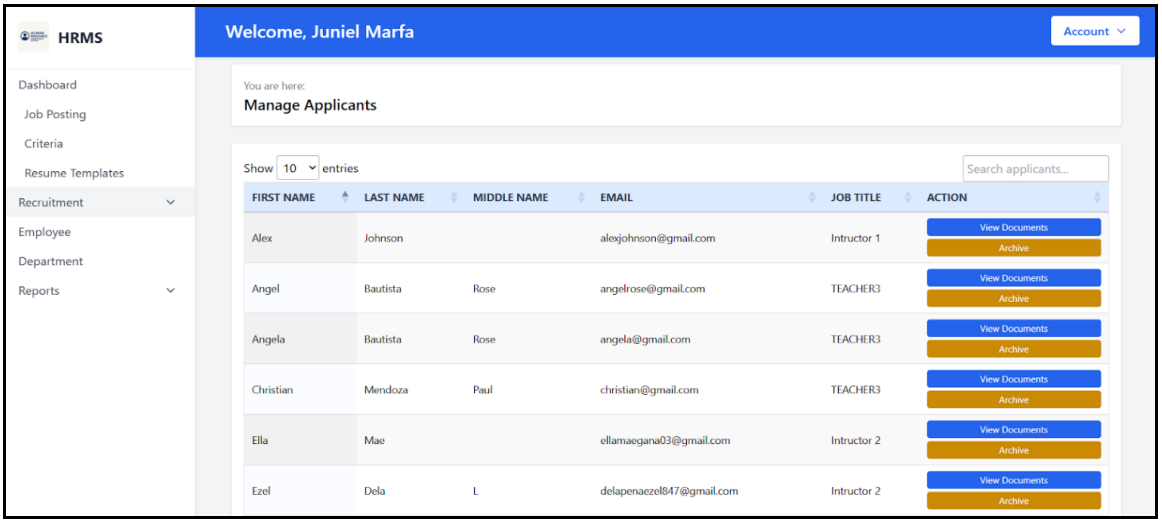

Figure 4. Applicants

Figure 4 shows all applicants who submitted for each open job title. In this part of the system, the submitted applicant information and uploaded resumes are collected and processed for evaluation. The system then performs predictive analytics by analyzing applicant data using machine learning and data mining techniques. Through this process, the system extracts relevant information from resumes, compares applicant qualifications with the job criteria, and evaluates candidate suitability. Machine learning algorithms analyze patterns from existing recruitment data to assist in predicting and identifying the most qualified candidates. This process helps HR personnel efficiently review applicants and supports data-driven recruitment decision-making.

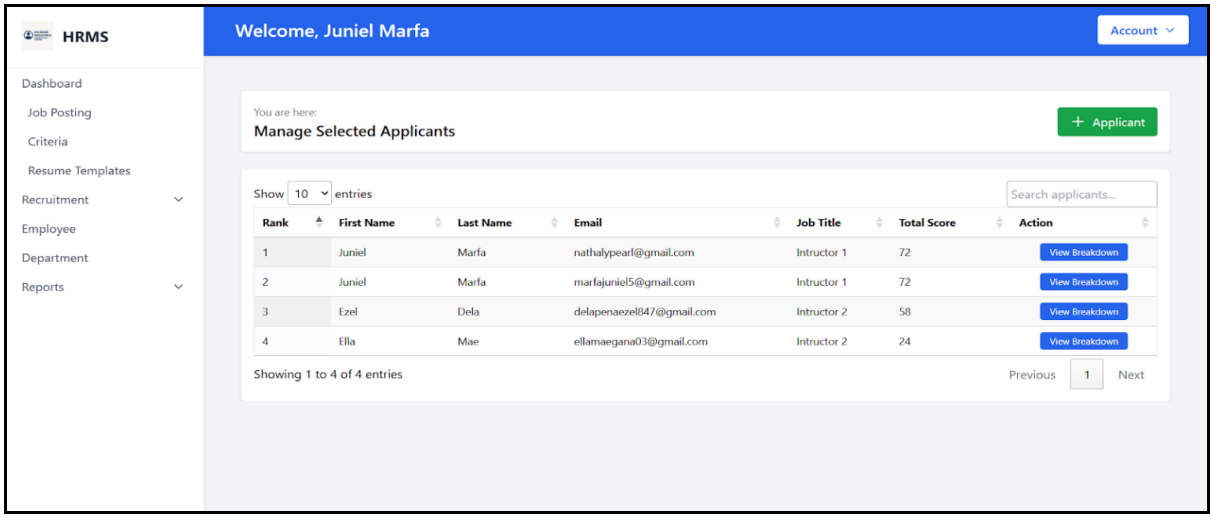

Figure 5. Selected Applicants

Figure 5 presents the list of applicants endorsed by the system after the evaluation process. The endorsement is generated based on the analysis performed by the predictive analytics module, which uses machine learning, data mining, and resume analysis to assess applicant qualifications. The system evaluates the extracted resume data, compares it with the predefined job criteria, and ranks candidates according to their suitability for the position. Applicants who meet the required qualifications are automatically endorsed by the system to assist HR personnel in the recruitment and selection process.

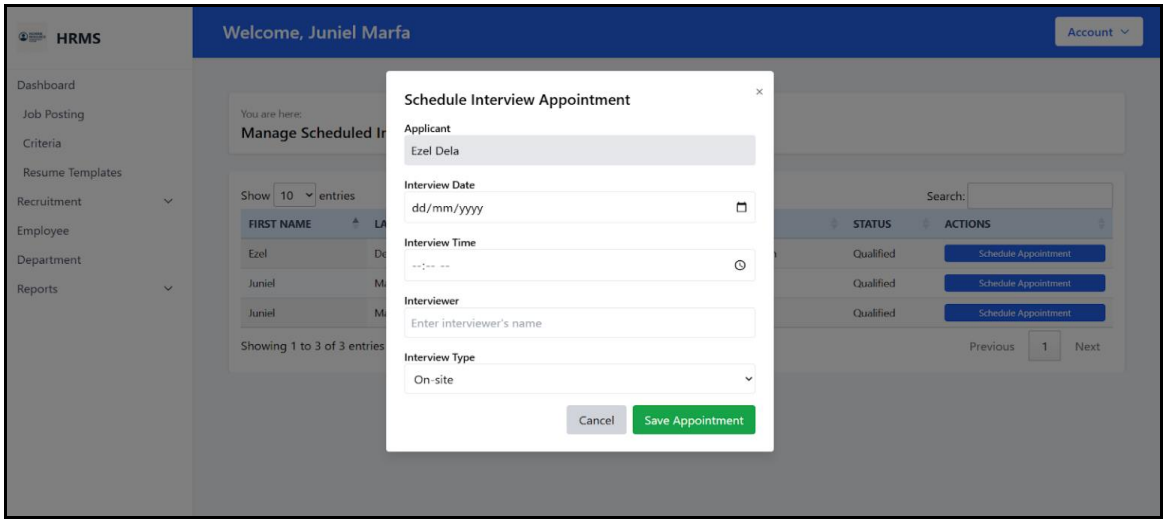

Figure 6. Scheduled Interview Applicants

Figure 6 shows that the administrator can now set schedule interview for endorsed applicants. In this part of the system, HR personnel or administrators can manage and assign interview appointments for qualified candidates who were identified through the predictive analytics and evaluation process. The system allows the administrator to organize an interview date, times, interviewer to help streamline the recruitment process and ensure that the candidate evaluations are conducted in a timely and organized manner.

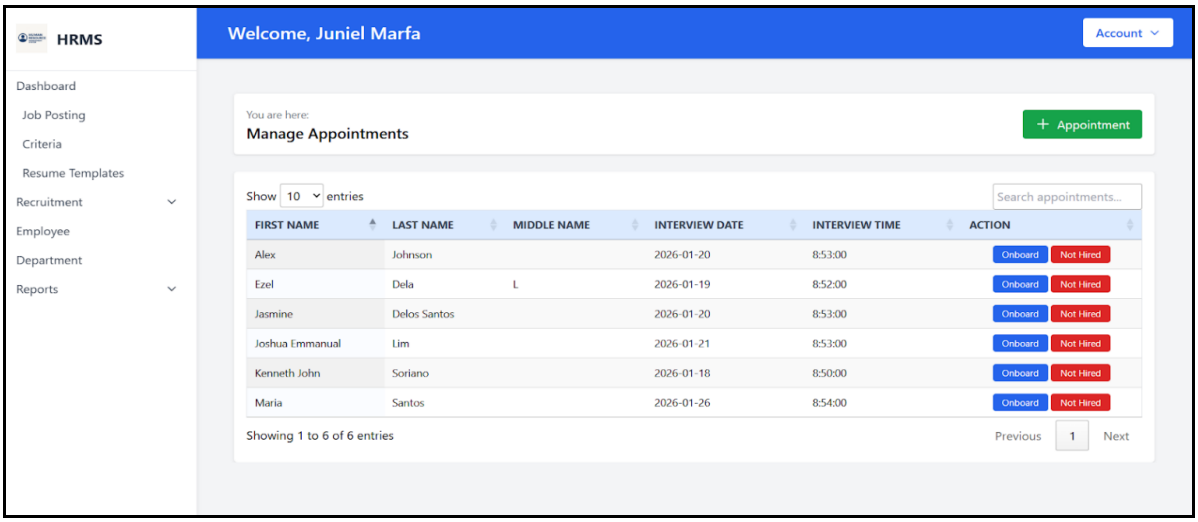

Figure 7. Appointment

Figure 7 presents a list of applicants who have been scheduled for an interview appointment. This section of the system displays the applicants who were endorsed and assigned an interview schedule by the administrator. After the interview process, the administrator can evaluate the applicants and decide whether to proceed with onboarding or mark the applicant as not hired. This feature allows HR personnel to manage recruitment decisions efficiently while ensuring that only the qualified candidates proceed to the onboarding stage.

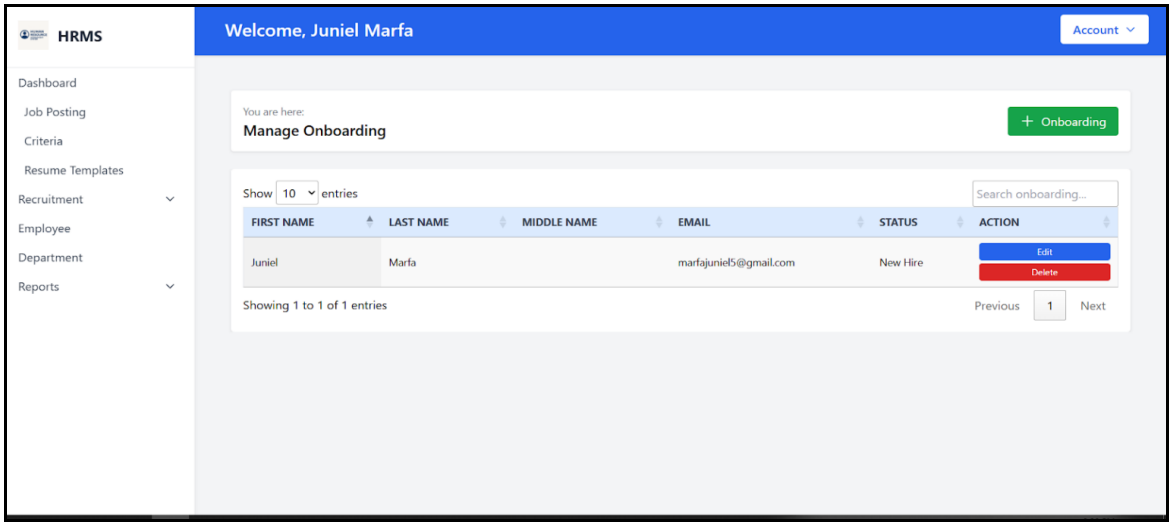

Figure 8. Onboarding

Figure 8 presents the section of the system where HR personnel and administrators can manage all the details of the onboarding employee. In this part of the system, authorized users can input and modify essential employee information, such as personal details, job position, department, and other required onboarding data. This feature ensures that newly hired employees' records are accurately stored and maintained in the system, allowing HR personnel to efficiently manage employee information and facilitate a smooth onboarding process.

II. CONCLUSIONS

The The study concludes that the developed Predictive Analytics in Human Resource System successfully achieved its objectives and was evaluated as functional, user-friendly, and effective in supporting human resource operations. The system improved the efficiency of HR processes by streamlining recruitment activities, automating resume screening, and assisting in candidate evaluation through predictive analytics, machine learning, and data mining techniques. By integrating these technologies, the system enables data-driven recruitment and decision-making, helping HR personnel identify qualified candidates more efficiently. Furthermore, the software quality evaluation indicated that the system performs well in terms of maintainability, adaptability, and potential for future integration, making it suitable for practical implementation within organizations seeking to modernize and digitize their HR management processes.

Recommendations

Based on the findings of the study, several recommendations are proposed to further enhance the system. First, the interview scheduling and appointment processing modules may be improved by incorporating automated notifications and calendar integration to ensure better coordination between HR personnel and applicants. Second, the predictive analytics component can be further optimized by refining machine learning algorithms and expanding the dataset used for training to improve prediction accuracy and reliability. Lastly, improvements in the user interface design and workflow consistency are recommended to enhance system usability, allowing HR personnel and system users to perform tasks more efficiently and effectively.

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