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Research Paper

Data-driven employee selection and promotion on selected institutions in NCR with predictive analytics

Ma. Christina Navarro*
*Graduate Studies, Department of Computer Science, AMA University, Philippines.

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ABSTRACT

This study aims to develop a data-driven system for employee selection and promotion using predictive analytics in selected institutions within the National Capital Region (NCR). The common methods used for job promotions create various challenges because they lack objectivity and demonstrate inconsistent procedures which result in wrongful outcomes and wasted potential. The researchers created an intelligent human resource platform which they developed using a quantitative research methodology. The system uses machine learning together with large language models (LLMs) to process two types of data which include structured data about performance scores and training history and competencies and unstructured data about narrative evaluations. The researchers used the FURPS model which includes Functionality, Usability, Reliability, Performance and Supportability to assess system effectiveness while using statistical methods that included descriptive analysis and ANOVA. HR professionals and institutional decision-makers provided feedback which showed they were highly satisfied with all evaluation criteria. The platform helps organizations by providing tools that improve decision-making processes and increase visibility and improve their workforce management operations. The system provides an organization flexible option that uses data analysis to transform their current methods of employee evaluation and promotion assessment into modern practices.

Corresponding Author:
Ma. Christina Navarro
Graduate Studies, Department of Computer Science, AMA University, Philippines.
Email: ma.christina.navarro@adamson.edu.ph

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1. INTRODUCTION

The increasing need for unbiased HR management practices which require all HR processes to operate in an open manner has led organizations to implement tools which support decision-making based on data analysis. Predictive analytics uses statistical models together with machine learning algorithms to analyze historical data because it provides an effective method for predicting employee performance and promotion readiness and career growth potential [1], [2]. HR departments can use predictive systems which analyze extensive datasets to make decisions that support both organizational objectives and employee development plans.

The National Capital Region (NCR) institutions which use traditional employee selection and promotion methods still exist despite the benefits which predictive analytics offers. The manual processes which organizations use to handle employee selection and promotion create operational difficulties because they produce inconsistent results which lead to bias and fail to integrate essential data sources. The process of accessing and analyzing performance appraisals together with training certifications and supervisor feedback becomes difficult because multiple departments store employee records in different formats [3], [4].

As a result, HR decision-making is frequently delayed and lacks a standardized framework for evaluating employee readiness for advancement. The existing HR practices create a fundamental problem because organizations need to establish fair evaluation systems which depend on precise data for staff promotions. Employment systems need intelligent technology which can handle both organized and disorganized information and they need this technology to identify suitable candidates while eliminating existing operational problems [5], [6].

The research proposes a data-driven employee selection and promotion system which will use predictive analytics and machine learning techniques to solve existing organizational problems. The system evaluates staff promotion eligibility through performance metrics assessment and training record assessment and other HR indicators examination [7], [8], [9].

The system will use large language models (LLMs) to analyze unstructured information which includes narrative feedback together with qualitative evaluations to provide a complete assessment of employee advancement possibilities. Participating NCR institutions can use this system to update their human resources operations which will help them use scientific evidence instead of personal evaluation methods. The platform uses data-driven insights to provide clear promotion recommendations which will help HR professionals and decision-makers achieve better fairness and accuracy and operational efficiency during promotion evaluations [10], [11].

2. RELATED WORK

The combination of structured HR systems together with predictive decision-making tools establishes a basis for conducting fair and efficient decision processes according to multiple research studies. Table 1 contains a summary of related studies that shows their research focus and adopted research methods which connect to this investigation.

[12] Studied human resource management methods used in selected Philippine banks. The research demonstrated that structured HR systems create a substantial effect on employee performance. The study established that organizations need consistent HR procedures which include recruitment evaluation and promotion to define their HR processes. The research findings demonstrate that organizations should implement data-driven decision-making processes in their HR departments to improve efficiency and fairness.

[13] Designed a human resource management framework which provides strategic guidance to Philippine state universities and colleges. The study showed that HR functions need to align with institutional goals. The study showed that organizations need to implement systematic tools together with predictive tools for selection and promotion process management. [13] Proposed that organizations should use digital platforms to solve the typical problems which occur in manual HR systems. These problems

include processed records which become disjointed through execution of the HR systems and evaluation methods which become disorganized through the HR evaluation systems [14].

[15] Studied the relationship between employee performance and the effects of recruitment and selection methods on their recruitment and selection methods. Their quantitative research demonstrated that organizations achieve better results when they use selection procedures which establish clear requirements and operational standards for their selection process. The authors recommended that organizations implement predictive systems to enable their talent acquisition and internal promotion processes to make data-driven decisions.

[3] The research investigated the impact of high-performance work practices (HPWPs) on two employee outcomes, which include performance and engagement. The research established that organizations achieve better employee results through the implementation of structured HR systems, which include training programs and performance-based evaluation methods.

The studies provide foundational knowledge needed to create intelligent HR systems, which use predictive analytics for employee selection and promotion processes. They show a shared recognition of the limitations of manual systems and highlight the increasing need for a data-driven tool to improve decision-making in human resource management [16], as shown in Table 1.

Table 1. Matrix of Related Studies on Data-Driven Employee Selection and Promotion

Title of Study	Focus / Purpose	Technology Used	Relevance to Current Study
Investigating human resource practices and its impact on employee performance in selected banks in the Philippines	To examine the effects of HR practices on employee performance in Philippine banks	HR Analytics System, Descriptive Data Analysis	Establishes the foundational need for structured HR systems that support performance-based promotion.
Strategic Human Resource Management Framework for state universities and colleges in the Philippines	Align HR functions with institutional objectives through a strategic framework.	Digital HR Information Systems (HRIS), Framework Modeling	Integrate predictive tools into the HR systems from a long-term planning viewpoint as well as from that of automation.
Recruitment and Selection Impact on Employee Performance: A Quantitative Analysis	The objective of the research was to discern the influence of structured recruitment and selection processes on employee performance	Predictive Modeling, Statistical HR Tools	The predictive modeling approach establishes justification for making employee promotion decisions through its assessment of their earlier work achievements and established performance standards.
High-performance work practices, employee engagement, and employee performance	To assess how strategic HR practices impact employee engagement and performance	Structural Equation Modeling (SEM), Workforce Analytics	Supports the inclusion of engagement metrics in predictive analytics for more holistic promotion models.

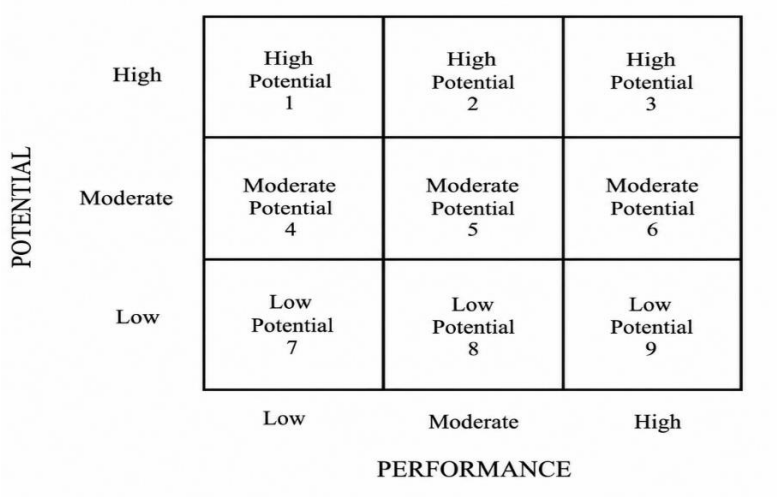


Figure 1. The 9-Box Grid

This two-dimensional measurement,

Figure 1 or the 9-Box Grid, allows human resource professionals to place employees in nine boxes that inform succession planning, talent development, and career progression strategies. An effective instrument for evaluating both performance and innovation potential in employees. It consists of a three-dimensional matrix, the vertical axis of which represents performance and the horizontal axis potential.

Employees who are both high performing and high potential are labeled future talent, while those who are high performing but lower potential are termed solid contributors in their current postings. On the other end are people who have high potential but are underperformers. Such individuals may require specialized training/mentoring for them to realize their potential. With

Figure 1 modeling of performance and potential, it allows the logical organization to spread development resources, make fair promotion decisions, and easy long-term workforce planning.

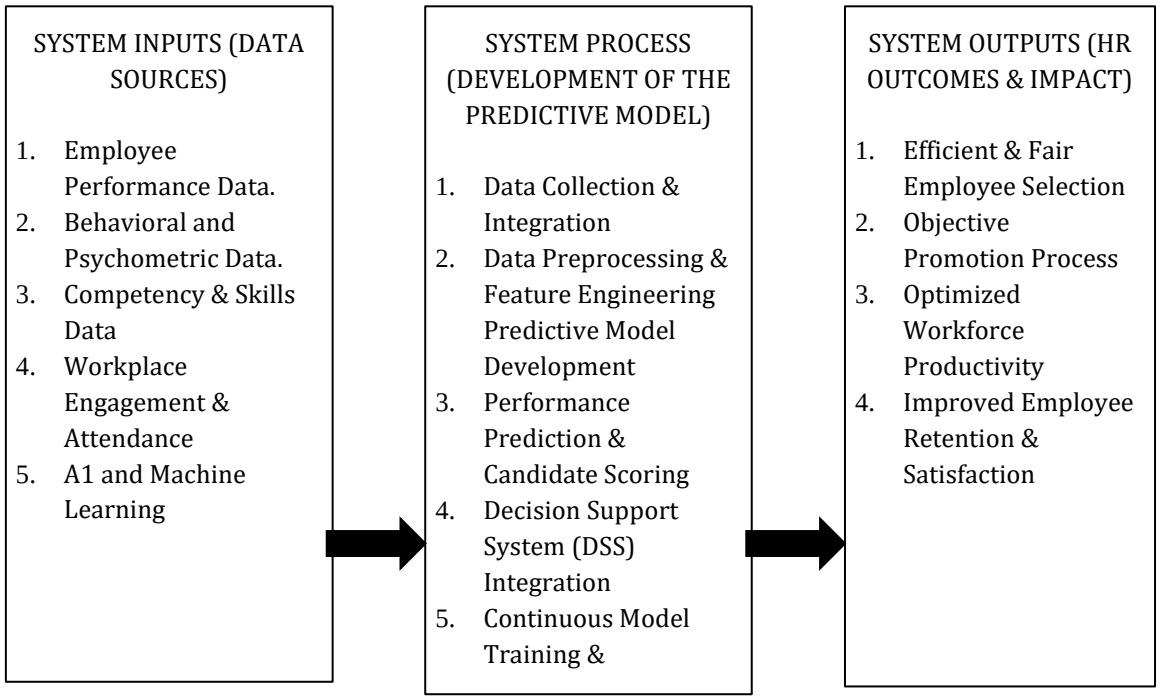


Figure 2. Conceptual Framework of the Data-Driven Employee Selection and Promotion System

3. METHODOLOGY

This study will use a quantitative research approach with a descriptive design to examine how predictive analytics influences employee selection and promotion within selected institutions in the National Capital Region (NCR). The project will gather and evaluate numerical data about employee performance and their skills and past promotion records to create a system which will enable data-based decision making.

The smart analytics system will be developed and implemented through a system development methodology which will use machine learning methods and language-based AI to automatically assess employee abilities and predict their promotion potential. The system's flow is illustrated in Figure *2* which shows the Input-Process-Output IPO framework that guides the development process.

The study will use Developmental Research methodology to conduct organized design work and system development and system assessment activities. The platform assessment will use the FURPS model which evaluates Functionality, Usability, Reliability, Performance and Supportability while the system effectiveness across user groups will be studied through descriptive statistics and ANOVA. The research will collect qualitative feedback to enhance understanding of user experience and actual usability.

3.1 Data Collection

Data for this study were obtained through a combination of primary and secondary sources. Researchers used structured surveys and questionnaires to collect primary data from HR personnel, department heads, and decision-makers who worked at selected institutions in the National Capital Region (NCR). The research team conducted interviews with key informants in order to collect qualitative data which helped develop the system design while ensuring that the data requirements stayed accurate and relevant.

The secondary data sources contained archival employee records which included performance appraisals together with training and certification histories and promotion outcomes and competency profiles. The participating institutions provided these datasets, which served as the foundation for training and testing the predictive models. The dataset included both quantitative records and qualitative textual inputs which created a solid base for training machine learning algorithms and large language models. The researchers used purposive sampling to choose respondents who had direct involvement with HR decision-making processes. All institutional data were anonymized in compliance with data privacy standards.

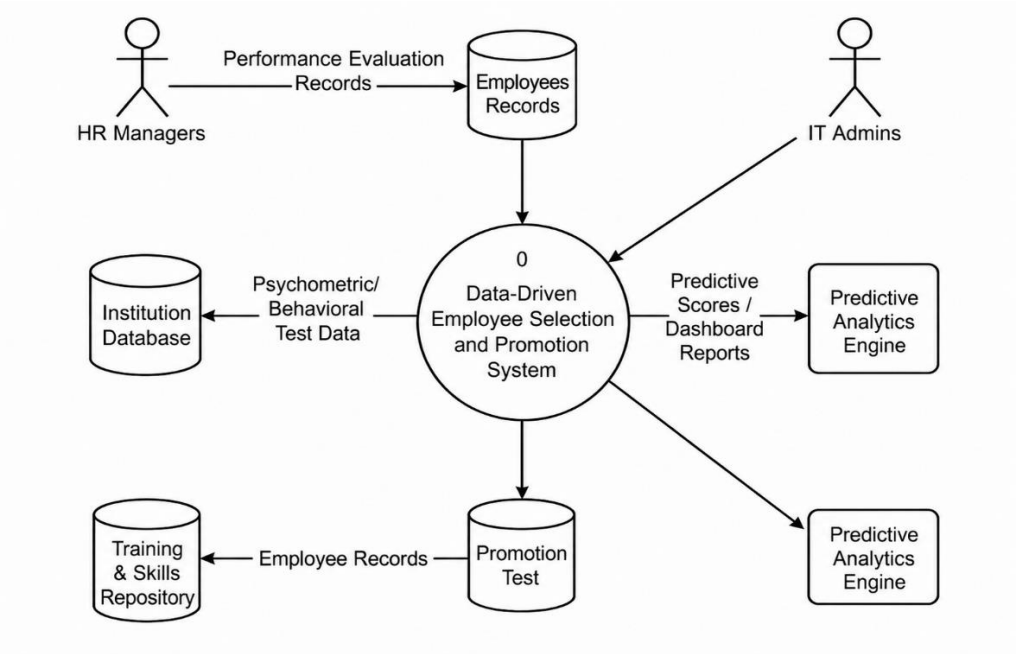


Figure 3. Data Flow Diagram of the Proposed System

The Data-Driven Employee Selection and Promotion System shows its information flow through Figure *3* which describes the system. The system uses employee data to produce outputs which help human resource decision-making through evidence-based methods and fair processes.

The input stage of the system receives data from multiple sources which include performance records and psychometric tests and behavioral assessments and competency assessments and attendance records and engagement data. The system uses multiple steps which start from data integration to continue through the stages of preprocessing and predictive modeling until it reaches candidate scoring. The system uses machine learning techniques to create predictive models which undergo continuous development to enhance model precision and dependability.

The outputs emphasize the practical usefulness of the system towards the field of human resource management: it gives a way for the provision of selection of employee with an objective that is quick and fair, promotes transparency during promotion processes, enhances workforce productivity, and encourages employee satisfaction and retention. In this way, the DFD is then setting the stage for how predictive analytics can dramatically transform past HR practices into something quick, just, and data driven.

3.2 Data Pre-Processing

The predictive analytics system development process for employee selection and promotion requires data pre-processing as its essential first step. The research team conducted a systematic process to clean and transform all HR datasets which included both structured and unstructured data. Institutional records such as performance evaluations, promotion histories, training logs, and competency ratings were first reviewed for completeness and consistency. The researchers solved data problems which involved absent data points and repeated records and inconsistent data presentation by using standard methods which included imputation and normalization and outlier detection.

The machine learning models required numeric transformation of categorical variables which included job position department and employment type while all numerical data required standardization. Natural language processing (NLP) techniques such as tokenization and stop-word removal and vectorization with word embeddings processed unstructured data which included narrative feedback and qualitative supervisor assessments to prepare them for analysis with large language models (LLMs) [3], [10]. The organization cleaned data was stored in structured formats within a secure cloud-based repository after the data processing was completed. The datasets for employee promotion system were prepared through creation of training and testing sets which were divided into different sections and assigned their respective indexes [1], [17], [18], [8].

3.3 Algorithm Selection

The accuracy and fairness and scalability of decision-making processes depend on selecting appropriate algorithms for the Data-Driven Employee Selection and Promotion System which uses predictive analytics. The selected algorithms need to process employee data which includes performance metrics and competencies and promotion histories because they require both structured and unstructured data processing capabilities and accurate prediction results and HR decision-making transparency. The system required algorithm selection to achieve its three main objectives which included detecting candidates ready for promotion and analyzing their performance abilities and delivering data-based human resource solutions to all NCR educational institutions according to [10], [18].

1. The Random Forest algorithm was chosen because it provides strong performance while achieving high classification results and it can handle extensive datasets that contain many different attributes. This ensemble learning method trains multiple decision trees which use their common output to generate predictions which helps reduce overfitting and improve predictive accuracy. The system effectively analyzes multidimensional employee data which consists of training records and performance appraisals and tenure information to accurately predict institutional promotion eligibility across different college environments [5].

2. Logistic Regression serves as the baseline model because it provides an easy-to-use system which HR professionals can understand. The algorithm uses weighted input variables to calculate the probability of promotion outcomes which shows HR practitioners how different attributes like performance rating and leadership score and years of service impact promotion decisions. Its transparent design makes it an effective base model for testing the performance of advanced algorithms according to [19].
3. The system uses Large Language Models (LLMs) to improve analysis of unstructured feedback which includes supervisor narratives and self-assessments and evaluation comments. The models use deep learning methods to interpret natural language while they extract vital information and determine employee readiness through their analysis of qualitative data. LLMs enable the system to process non-numeric information during decision-making which creates a complete picture of employee achievement and potential [4], [8], [20].

3.4 Performance Evaluation

In order to measure the overall acceptability and efficiency of the proposed approach, five critical quality factors, viz., Functionality, Usability, Reliability, Performance, Supportability, have been proposed, as shown in

Table 2, under an evaluation methodology called the FURPS approach.

Table 2. Furps Specification

Project Criteria		**Sample Population**			
Criteria	Description	HR Manager	Immediate Head	Employee	Total
Functionality	To what extent the system satisfies its intended functional specifications and supports the HR objectives such as selection and promotion.	10	20	27	57
Usability	Evaluates how users from different proficiency levels can interact with the system through its interface design which includes navigation elements and accessibility features.				
Reliability	Assesses system stability by testing how well systems maintain their performance after multiple tests and how they handle errors.				
Portability	The system tests its ability to respond promptly and adjust its operations when running on different devices and platforms which it needs for successful performance in educational environments.				
Supportability	The study evaluates system maintainability together with system support availability enable ongoing system enhancement and user input collection.				
Max Participant's		10	20	27	57

The researchers used the One-Way ANOVA statistical method to determine whether system evaluation results differed significantly. The test calculates the F-ratio according to the formula shown in Eq. 1.1:

$$F = \frac{MST}{MSE}$$

The ANOVA F-ratio calculation uses the Mean Square for Treatments (MST) and Mean Square for Errors (MSE) as its two components. The MST describes how group means differ from each other because it measures their group mean differences and MSE describes the average difference between people who belong to the same group. These elements are presented in Eq. 1.2 and Eq. 1.3, respectively:

$$MST = \frac{SST}{p-1} \qquad MSE = \frac{SSE}{n-p}$$

To compute SST, the squared differences between each group mean ($\bar{X}_j$) and the overall grand mean ($\bar{X}$) are multiplied by the number of respondents in each group (n_j) and summed across all groups, as shown in Eq. 1.4. On the other hand, SSE is calculated by summing the squared differences between each individual score (X_{ij}) and its corresponding group mean ($\bar{X}_j$) across all groups and respondents, as shown in Eq. 1.5:

$$SST = \sum_{j=1}^{p} n_j \ (\bar{X}_j + \bar{X})^2 \qquad SSE = \sum_{j=1}^{p} \sum_{i=1}^{n_j} (X_{ij} - \bar{X}_j)^2$$

4. RESULTS AND DISCUSSION

This chapter presents the data, analysis, interpretation, and discussion based on the statement of the problem. Using stratified random sampling, the researcher selected three categories of respondents: HR Managers, Immediate Heads, and Employees. A total of 57 respondents from selected NCR institutions participated, all of whom are involved in employee selection and promotion processes.

4.1 Mean of All Indicators

Presents the summarized weighted mean of the software's quality assessment based on five key indicators: functionality, usability, reliability, portability, and supportability, as evaluated by three respondent groups HR Manager, Immediate Head, and Employee as indicated in Table 3. The overall group responses across all indicators fall under the description "Strongly Agree", with weighted means ranging from 4.54 to 4.63, indicating a highly positive perception of the software's performance and quality.

Table 3. Summarized Weighted Mean of all Indicators

Indicators	Group of Respondents			Group Response	
	HR Manager	Immediate Head	Employee	Mean	Description
Functionality	4.59	4.56	4.47	4.54	Strongly Agree
Usability	4.67	4.61	4.58	4.59	Strongly Agree
Reliability	4.63	4.59	4.57	4.60	Strongly Agree
Portability	4.66	4.66	4.56	4.63	Strongly Agree
Supportability	4.62	4.57	4.58	4.59	Strongly Agree

4.2 Summary of Single Factor ANOVA with the Functionality, Usability, and Reliability

According to the results of the single factor ANOVA test on the functionality, usability, and reliability of the software, the generalities of users have shown statistically significant differences across the three quality indicators as shown in Table 4 Functionality, usability, and reliability found a mean score of 4.514, 4.588, and 4.599, respectively. Though apparently small, the average rating differences found

ANOVA results (F=3.90, p=0.027) to be greater than the critical value (F_{crit}=3.19), making these variations statistically significance. This leads to the conclusion that the software is perceived to be slightly better in reliability and usability than in functionality Figure 4**Error! Reference source not found.**.

Table 4. Summary of Single Factor ANOVA Results for Functionality, Usability, and Reliability

Groups	Count	Sum	Average	Variance
Functionality	17	76.7369	4.5139	0.0097
Usability	17	77.9973	4.5881	0.0085
Reliability	17	78.1798	4.5988	0.0097

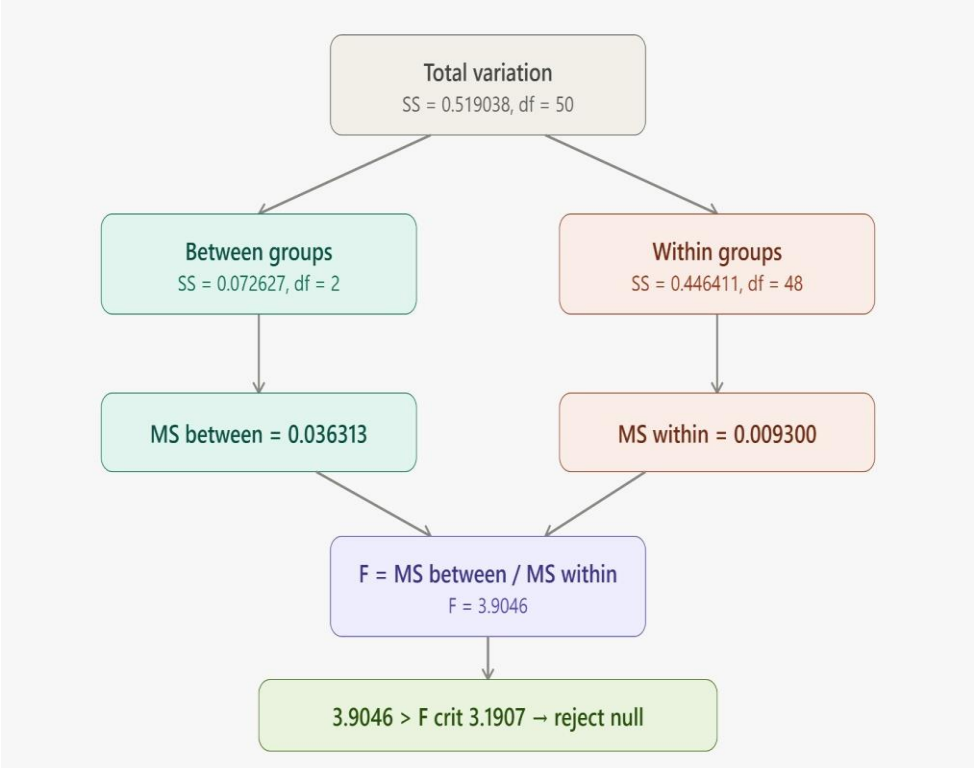


Figure 4. One-Way ANOVA Computation for Functionality, Usability and Reliability

5. CONCLUSION

Based on the results, the users that were composed of HR managers, immediate supervisors, and employees from selected NCR institutions strongly agree that the developed system significantly improves employee selection and promotion more efficiently. Throughout the FURPS criteria-Functionality, Usability, Reliability, Performance, and Supportability-the system received a high rating; this assumes its practicality and readiness for institutional use. Feedback received specified that the system was easy to operate, accessible to various users, and trustworthy in delivering data-driven insights necessary for equitable HR actions.

Its credibility was also validated by ANOVA analysis, it confirmed consistent perceptions across all respondent groups, showing no significant bias in the system's application. This consistent assessment of the system strengthened its credibility as a dependable solution for human resource operations. Overall the positive feedback shows that the system addresses key HR issues and supports ethical, data-driven improvements in the National Capital Region.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Ma. Christina Navarro	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The author declares no conflict of interest related to the conduct and publication of this study.

Informed Consent

The researchers have obtained the informed consent from all participants included in this study.

Ethical Approval

The researcher secured the necessary approvals from the institutions that contributed to the study to obtain both the ethical and the institutional clearance needed. The data collection processes were also aligned with the Data Privacy Act of 2012 in the Philippines, which recognizes the adequacy of measures to safeguard the privacy of the data subjects as well as their right to participate voluntarily.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access to the data is subject to institutional approval and must comply with the provisions of the Philippine Data Privacy Act of 2012 to ensure confidentiality and responsible use

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BIOGRAPHIE OF AUTHOR



Ma. Christina Navarro, is the Chairperson of the Computer Science Department and a dedicated researcher at Adamson University, specializing in artificial intelligence and research development. She holds both a Master of Science in Information Technology and a Master of Science in Computer Science, equipping her with a strong academic foundation in the computing field. Her research focuses on the development of AI-driven solutions for institutional applications, particularly within educational and enterprise systems. Through her leadership and scholarly work, she advocates for innovative, data-informed technologies that enhance organizational effectiveness and academic progress. Email: ma.christina.navarro@adamson.edu.ph