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Decision Support System for Personnel Selection

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Abstract*: *Personnel selection is one of the most critical functions of Human Resource Management (HRM). Apart from the straightforward fact that an organization should be staffed with the right people, a wrong hiring decision can lead to serious consequences. This is one of the important decisions of the management on which the organizational development depends. This research aims to develop a decision support model for personnel selection by applying the C4.5 Decision Tree Algorithm. The decision support model was implemented by simulating the 110 applicants record and it was evaluated in terms of accuracy, error rate, precision and recall. The result of the evaluation revealed that the model has 98.4% accuracy, 1.4% error rate, 98.5% precision, and 98.7% recall which implies that it can provide an accurate and reliable result and valid to be used for supporting decisions. The Decision Support System for Personnel Selection is an innovative tool for human resource management specifically for recruitment and personnel selection that can help analyze complex data for decision-making process.

***Index Terms*: C4.5 Decision Tree, Data Mining, Decision Support System, Human Resource Management, Personnel Selection**

I. INTRODUCTION

Nowadays, the evolution of information technology applications makes it an absolute obligation on behalf of the decision makers to continuously make the best decisions in the shortest possible time. Activities in Human Resource Management (HRM) involve a lot of unstructured processes such as staffing, training, motivation and maintenance.

The application of data mining in various HR domains for decision support is increasing overtime due to the amount of datasets available in the domain that needs to be turned into meaningful information [1].

This research aims to develop a decision model using a C4.5 Decision Tree data mining technique to support personnel selection for recruitment that will help HR Officers in the applicant's evaluation and hiring process. This research applies to Higher Education Institutions (HEI's) specifically for State Universities and Colleges (SUC's) for the selection of applicants in teaching position. In HEI's, personnel selection process is conducted by hiring qualified and competent applicants. A Personnel Selection Committee is formed to screen and interview the applicants. Aside from the educational qualifications, they are evaluated using standard evaluation criteria which is composed of the evaluation and they are ranked based on their score. In the current process, the screening is based on the applicant's educational qualifications, length of experience, relevant trainings, and eligibility. The manual process of screening the documents is a tedious process, and once the applicants are qualified, they will be scheduled for interview, evaluation, and ranking. However, the result of the ranking is subject to the discretion of the head of the institution and the result of the ranking may not be actually followed.

Thus, these observations inspired the researcher to conduct the study and address the gap of knowledge in the field of HRM. The development of a decision support model for personnel selection will provide a predictive framework that will generate an automated semi-structured decision in evaluating the applicant's qualification. The model will automatically analyze if the application will be accepted or rejected and the generated decision will help the Human Resource Officers select only those qualified applicants.

II. METHODOLOGY

A. Decision Tree Method of Classification

This study used the C4.5 algorithm in Data Mining as a Decision Tree Classifier to generate a decision based on a certain sample of data (predictors) [2].

B. Dataset

The dataset was taken from the Iloilo Science and Technology University (ISAT U) Miagao Campus Human Resource Office. The researcher wrote a letter to the Campus Administrator through the Human Resource Officer asking permission to conduct the study and gather relevant data about the applicants record. There were 126 applicants record collected from academic year 2010 to 2018. To ensure the protection of data and adhere to the data privacy law, the applicants name were not revealed and an alias was assigned to preserve the confidentiality of the records. Feature selection and data cleaning was performed to select the most important feature that contributes to the prediction variable and these include the educational qualifications, work experience, relevant trainings, and eligibility.

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Table 1 presents the attributes used for the selection criteria.

TABLE I APPLICANTS ATTRIBUTES USED FOR SELECTION JUSTIFICATION

S/NO	Selected Attributes
1	Educational Qualifications
2	Experience
3	Trainings
4	Eligibility

C. Experimental Design

The experimental design of this study involves the application of the proposed framework to develop a model for personnel selection to support recruitment decisions. Fig. 1 illustrates the proposed framework which consists of three phases: preliminary phase, decision tree based personnel selection rules extraction phase, and implementation of personnel selection model phase.

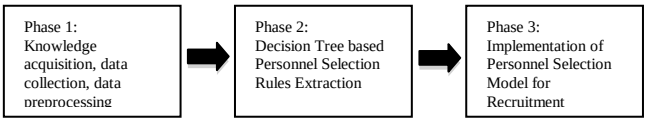

Figure 1. Personnel selection model.

Phase 1: Preliminary Phase

This phase consists of preliminary stages: knowledge acquisition, data collection and data preprocessing stages. In this phase, all the necessary data needed to carry out the experimentation were collected and a data preprocessing was performed to eliminate irrelevant data. After the preprocessing of the dataset, out of 126 records 110 were accepted and 16 were eliminated.

Phase 2: Decision Tree based Personnel Selection Rules Extraction

This phase consist of the construction of the Decision Tree and the formulation of the personnel selection rule that was used to evaluate the applicants. The development of the model was based on the NBC Common Criteria for Evaluation (CCE) ("National Budget Circular") which is composed of the educational qualifications, work experience, relevant trainings, and eligibility. To construct the decision tree, the numerical values of the criteria were converted into parameters to set the predictors and generate the rule. Table 2 illustrates the parameters used.

TABLE II DECISION PREDICTORS

Predictors	Range
Education	
• Baccalaureate	< 65
• Graduate Degree	> = 65
Experience	
• Max	> = 5
• Min	< 5
Trainings	
• More	> = 10
• Less	< 10
Eligibility	
• Yes	> = 1
• No	0

The predictors in table 2 were used to generate the rule of the decision tree. The formulated rules serve as the basis in the evaluation of the applicants' record and decide if the applicants will be accepted or rejected. The construction of the decision tree is based on the entropy and information gain [3]. Entropy is the measures of impurity, disorder or uncertainty in a bunch of examples; it controls how a Decision Tree decides to split the data.

The equation of entropy:

$$Entropy = \Sigma_{p}(X)\log_{p}(X) \quad (1)$$

where p(X) is a fraction of examples in a given class.

Information gain measures how much "information" a feature gives us about the class and it is the main key that is used by Decision Tree Algorithms to construct a Decision Tree.

The equation of Information Gain:

*Information Gain = entropy (parent) – [weighted average] * entropy (children)* (2)

Fig. 2 illustrates the Decision Tree.

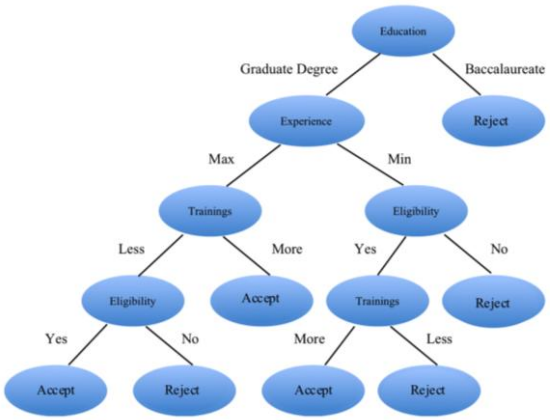

Figure 2. Personnel selection decision tree.

Phase 3: Implementation of Personnel Selection Model for Recruitment

In this phase, the DSS model for personnel selection was implemented by simulating the data.

III. EVALUATION PROCEDURE

To ensure the integrity and correctness of the data, a 10 fold cross-validation was used, such that the initial data are randomly partitioned into 10 mutually exclusive subsets or "folds". It was divided into a two sets, 60% was used as a training set and 40% was used as a testing set, this was performed using the Waikato Environment for Knowledge Analysis (Weka). The evaluation measurements used in this study were the accuracy (percentage of correctly classified set of tuples), error rate (complement of accuracy),

precision (percentage of tuples correctly classified by the model as positive (selected) or negative (rejected) out of positive (selected) class or negative (rejected) class of tuples respectively) and recall (percentage of correctly classified tuples by the model as positive or negative) [4].
Assuming in a dataset D containing n total records, TP represents number of tuples that are correctly classified as positive (selected) by a model M, TN represents number of tuples that are correctly classified as negative (rejected) by M, FP represents the number of tuples that are incorrectly classified as positive (selected) and FN as number of tuples incorrectly classified as negative (rejected).

The equations were defined as follows:

$$Accuracy\ \%\ (M) = ((TP + TN) / n) * 100 \quad (3)$$

$$Error\ rate\ \%\ (M) = 100 - Accuracy\ \%\ (M) \quad (4)$$

$$Precision\ \%\ (M) = (TP / (TP + TN)) * 100 \quad (5)$$

$$Recall\ \%\ (M) = (TP / (TP + FN)) * 100 \quad (6)$$

IV. RESULT

Based on the simulation of 110 records from the dataset, 103 or 93.63% of the data were correctly classified instances and 7 or 6.37% were incorrectly classified instances. The correctly classified data were those that contain a complete and valid value, while those incorrectly classified data were not accepted by the system due to invalid or incomplete value. The result of the evaluation of the decision tree personnel selection model is presented in Table 3.

TABLE III EVALUATION RESULT OF THE DECISION TREE PERSONNEL SELECTION MODEL

Accuracy (%)	Error Rate (%)	Precision (%)	Recall (%)
98.4	1.4	98.5	98.7

It was observed that the model has a high level of accuracy of 98.4%. Accuracy refers to the truthfulness of the content of the record and above the 90% threshold is already considered as highly accurate [5]. The result of the evaluation implies that the model contains more accurate and applicable rules and it is valid to be used for supporting decisions. In terms of error rate, the model has a lower error rate of 1.4%. Error rate is the degree of error that occurs in the system, the higher the error rate, the less reliable the system is. The result of the evaluation implies that the model is capable of interpreting the result of the personnel evaluation and the semi-structured decision that it generates is reliable. In terms of precision and recall, it was observed that the model has a high level of Precision which is 98.5% and Recall which is 98.7%. Precision means the percentage of the results that are relevant and recall refers to the percentage of total relevant results correctly classified by the model. The result of the evaluation implies that the model can correctly classify the data and produce relevant results.

V. CONCLUSIONS

Based on the result of the study, the following conclusions were drawn:
1. The DSS Model for personnel selection can provide an accurate and reliable result which can serve as basis in selecting applicants.
2. The semi-structured decision support can assist human resource officers in the decision making process in terms of recruitment and personnel selection.
3. The DSS Model can serve as an innovative tool for human resource management specifically for recruitment and personnel selection process based on the excellent result of the evaluation in terms of performance efficiency.

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Ramil G. Lumauag is the Head of the Office of Instruction of Iloilo Science and Technology University Miagao Campus, Miagao, Iloilo, Philippines. He obtained his Doctor of Education degree at the University of the Visayas Cebu City in 2016. He finished his Master of Science in Computer Science at the University of Negros Occidental-Recoletos Bacolod City, the same university also where he finished his Bachelor of Science in Computer Science degree.
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