



INTERNATIONAL JOURNAL ON INFORMATICS VISUALIZATION

journal homepage : www.joiv.org/index.php/joiv



Analysis of Job Recommendations in Vocational Education Using the Intelligent Job Matching Model

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Abstract—Vocational high schools are one of the educational stages impacted by Indonesia's low quality of education. Vocational High Schools play a crucial role in improving human resources. Graduates of Vocational High Schools can continue their education at universities or enter the workforce directly. Many students are found to have not yet considered their career path after graduation. At the same time, graduates are still expected to find mismatched employment with their expertise and skills. This research uses CRISP-DM, or Cross Industry Standard Process for Data Mining, to build machine learning models. The approach used is content-based filtering. This model recommends items similar to previously liked or selected items by the user. Item similarity can be calculated based on the features of the items being compared. After students receive job recommendations through intelligent job matching, they can use these recommendations as references when applying for jobs that align with their results. This process helps students direct their steps toward finding jobs that match their profiles, ultimately increasing their chances of success in the job market. These recommendations are crucial in guiding students toward career paths that align with their abilities and interests. The Intelligent Job Matching Model developed in this research provides recommendations for the job-matching process. This model benefits graduates by providing job recommendations aligned with their profiles and offers advantages to the job market. By implementing the Model of Intelligent Job Matching in the recruitment process, applicants with job qualifications can be matched effectively.

Keywords—Intelligent job matching; CRISP-DM; content-based filtering; machine learning.

Manuscript received 6 Oct. 2023; revised 31 Jan. 2024; accepted 14 Feb. 2023. Date of publication 31 Mar. 2024.
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I. INTRODUCTION

Vocational High Schools are one of the educational stages affected by the low quality of education in Indonesia. Vocational High Schools play a crucial role in improving human resources. Graduates of Vocational High Schools can continue their education at universities or enter the workforce directly. Many students are found to have not thought about what they will pursue after graduation, and in terms of graduates, there are still cases where they work in positions that do not match their skills and abilities. Developing the Vocational High School curriculum focuses on assessing student learning outcomes rather than developing student competencies [1].

Students must develop competencies during learning to determine their goals after graduation. The job search and career planning process require equipping hard and soft skills.

The major challenge for the world of education is to integrate both aspects to prepare human resources with the skills to work and grow in the future. Competency development will guide students in career planning [2].

A career is a person's success and progress in their job and occurs throughout their lifetime [3]. Students' career maturity indicates they can self-develop, make decisions, and pursue a profession that aligns with their career group. The Minister of Education and Culture in Indonesia is developing policies related to linking and matching the education curriculum to enhance the relevance of Vocational High Schools to the needs of the job market, business world, and industry.

Link and Match is considered an exploration of the competencies required by the future job market [4]. Link and Match policies are divided into two targets, namely the Secondary School and Higher Education levels. At the Secondary School level, the government's program aims to change the ratio between General High Schools and

Vocational High Schools from the original 70:30 to 30:70. Link and Match creates a reciprocal relationship between the world of education and the world of work, allowing the development of educational curricula to be tailored to job needs [5].

The implementation of Link and Match prepares students for their internship, where students who previously had no understanding of the working world now know what they will do and how to do it. Link and Match can reduce the number of unemployed Vocational High School graduates, which increases every year. The Link and Match policy is limited to bridging the gap between the world of education and the world of work. New issues have arisen regarding the alignment of jobs with the competencies possessed. Job recommendations are highly needed for fresh graduates during the job search process. The Link and Match policy can address this issue by implementing a Job Matching system. Job Matching is a program that promotes various job fields to graduates.

Job Matching is conducted to enhance the understanding of the job market based on the skills possessed by applicants. Strengthening the Link and Match policy and the Job Matching system can be achieved by developing the Intelligent Job Matching Model. This model results from collaboration between Link and Match and the Job Matching system, which will provide job recommendations based on abilities or competencies.

The Intelligent Job Matching Model is a model that assists in the job search process for fresh graduates. The Intelligent Job Matching Model provides job recommendations that align with the competencies of the graduates by categorizing each graduate based on job fields. The Intelligent Job Matching Model uses three methods for job application matching: 1) matching based on CV/Resume, 2) matching based on Personality Tests, and 3) matching based on Competency Tests [6].

The Intelligent Job Matching Model applies the Content-Based Filtering method, which operates based on the principle of providing recommendations based on the matching results according to an individual's profile [7]. Implementing the Intelligent Job Matching Model using the Content-Based Filtering method is reinforced by the advancements in science and technology as a bridge between humans and machines. Computer technology used to be a means to calculate, process, and present information, but now computers can replace human roles and handle complex tasks. The computer technology that plays a role in the Intelligent Job Matching Model is Machine Learning. The application of Machine Learning is used to assist in automatically filtering job applications [8].

II. MATERIALS AND METHOD

This related study aims to identify the key factors influencing the success of Link and Match between Vocational Education and the Industry. The research employs a qualitative method to analyze the phenomenon of Link and Match between TVET (Technical and Vocational Education and Training) and the industrial sector in Indonesia. Nine crucial factors play a significant role in establishing a compelling connection between TVET and the industry's needs [9]. These findings emphasize the importance of

enhancing the relevance and alignment of TVET programs with the demands of the industrial world to ensure better quality graduates.

It is understanding the role of vocational or vocational education in its relationship with the industrial or work world. Specifically, the significance of practical job training in preparing learners to enter the workforce. Comprehensive insights related to the Link and Match policy concept, which aims to integrate vocational education with the demands of the industrial world [10] and the strong connection between the vocational education curriculum and the fields of expertise with the job market's needs.

A job-matching application system that extracts information from resumes or applicant profiles. Practical job training is significant in preparing learners for the workforce. This system can identify applicants' compatibility with job qualifications through resumes or applicant profiles [11]. The job-matching information system makes it easier for vocational high school graduates to understand the industrial world and assists them in finding suitable employment [12]. They are identifying job mismatch as a qualitative imbalance that occurs when the characteristics of workers (educational level, competencies, or skills) do not align with job requirements. This system can enhance alignment by balancing education to develop competencies or skills with job requirements [13].

The method used in this research is research, Research and Development (R&D). Research and Development (R&D) is a method used to generate specific products and test their effectiveness. The Research and Development (R&D) method is employed in developing the Intelligent Job Matching Model to produce new innovations in the field of technology and vocational education.

The architecture of this research system involves several key stages. At the core of this approach is creating an Intelligent Job Matching model to connect various variables. This will be followed by data collection, involving information from different relevant sources. Subsequently, data analysis will uncover patterns and insights, guiding the data preprocessing steps to enhance data quality [14]. The training data will then be utilized to adjust model parameters for more accurate predictions, marking the final step in developing this model [15]. All these interconnected components form the systematic framework of this research approach.

A. The Research Model

The research approach to building the system uses the Development and Operations (DevOps) method, thus obtaining a detailed overview of both local and general characteristics [16].

1) Development

- Plan. In this stage, the researcher conducts a needs planning for building the Job Matching system for vocational learning, identifies issues, sets system objectives, identifies system constraints, and conducts a feasibility study, including technical aspects, to determine if the proposed system can be developed and implemented using existing or new technology,

economic aspects (cost support), legal considerations, operational factors, and scheduling.

- Code. In this stage, the researcher analyses the system to be designed. The current system analysis involves field analysis, while the proposed analysis depicts the analysis of the system to be designed. Next is the system design phase, which includes designing the flow or diagrams and the database.
- Build. In this stage, the researcher compiles resources and frontend code as the system's main interface, and backend code for server management.
- Test. At this stage, the system has been built, and the researcher conducts testing to determine whether the system functions successfully or not.

2) Operations

- Deploy. In the previous stage, the system has been successfully tested; therefore, the system is now implemented or applied in the learning process.
- Operate. Subsequently, the system is operated directly.
- Monitor. In this stage, the researcher merely observes and controls the system's operation.
- Release. The final stage involves the researcher's initial publication in the learning process, to make it accessible effectively.

B. Machine learning approach

To build the machine learning model in this research, the Cross Industry Standard Process for Data Mining (CRISP-DM) is employed [17]. The chosen model approach is content-based filtering [18]. This model recommends items similar to previously liked or selected items by the user. Item similarity can be calculated based on the features existing in the compared items [19]. This method is user-independent, meaning it does not depend on whether or not the item is new (never selected by any user before).

C. Data Collection

Data collection for creating the Intelligent Job Matching model is gathering information relevant to jobs, qualifications, and user preferences that will be used to develop correlations and suitable job recommendations. The collected data includes information about available jobs, applicant profiles, skills, education, work experience, location preferences, and other relevant factors [20]. This data can be obtained from various sources, such as job search websites, company databases, and user profiles.

1) Competency Test Data:

The Competency Test is conducted to measure the competency achievements of each student in their respective fields of expertise during the learning period [21]. The Competency Test consists of questions related to the subject matter learned in a specific field of knowledge [22]. Twelfth grade students carry out this test.

2) Personality Test Data:

The Personality Test is conducted to determine the compatibility of students' personality types with the chosen career field [23]. The Personality Test is a questionnaire or survey containing statements related to personality traits [24].

D. Data Preparation

In this stage, several tasks must be performed, including data cleaning, data selection, records, attribute selection, and data transformation to prepare it as input for the modeling stage [25]. Data processing is done by designing an assessment rubric for competency and personality tests [26]. The assessment rubric is developed to establish evaluation criteria for the conducted tests [27]. This assessment rubric will define the test results for each student, which are obtained to determine the compatibility of jobs with the competencies and personalities of the students [28].

E. Data Analysis

The data analysis process involves a series of crucial stages. Firstly, there is the preprocessing stage, which includes data cleaning and preparation for further analysis. Subsequently, similarity calculations are performed using the TF-IDF method and cosine similarity calculations to measure data similarity. The results of these calculations are utilized in the analysis and modeling process [29]. Next, a predictive model generates job recommendations that align with individual profiles. Finally, the created model is saved for further usage and evaluation.

1) *Preprocessing:* Then, I carried out a series of preprocessing steps using 4 data frames before starting to build the recommendation system:

- Enc_id. I created a field called "enc_id," an encoded job id. Then, I turned the job id into a string type by adding 'A' in front of the numeric job id. This helps in providing recommendations in the subsequent stages.
- Job Details up to Ranking. I joined the ranking table with job details through SQL, which is similar to joining and filtering all rows where the job title is not available.
- Only the top 100 jobs with the highest popularity ratings were selected for this analysis. First, I identified the most frequently read books. To do this, I looked at which job IDs were the most popular and then assigned a minimum rating of 100 times. Then, I joined these jobs with the rankings to calculate the average ranking of jobs whose IDs were among the most frequently favored.
- Prepare Tag Details. Next, I prepared tag details, which I used as attributes for content-based filtering. Combining the job_tag table with tagdetails, I obtained tag names and counts of how many times a particular job had been tagged with a specific tag in a single table, as seen in table 1. Then, I created a cross table where each item was stored in one row, and each attribute was a column indicating whether or not the item had that attribute. We will use this table for similarity calculations to find similar jobs.

TABLE I
DATASET MODEL INTELLIGENT JOB MATCHING

No	Name	Work
1	Raudhoh Fitra Humamy	Programmer

100	Mochamad Elang	Quality Control

2) *Similarity Calculations*: Now, similarity between items can be calculated based on the table. The similarity score will

range between 0 and 1, with higher values indicating more similar items.

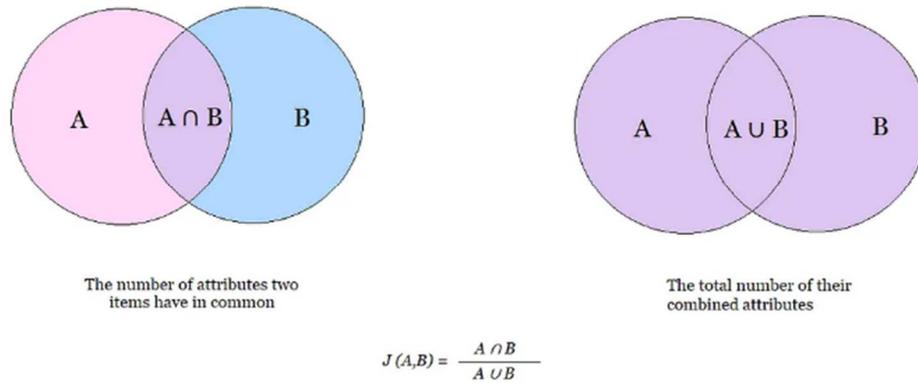


Fig. 1 Jaccard Similarity Calculation

In Figure 1, since the cross table consists of 0s and 1s, I have performed bitwise logical operations; otherwise, Jaccard similarity would mostly result in 0.

3) *TF-IDF and Cosine similarity*: In general, document similarity is obtained from the description of a document using the TF-IDF concept. TF-IDF is a subarea of Natural Language Processing (NLP) used in information retrieval to extract data [30]. Simply put, it calculates how often each word appears in a document, assigns a weight to each word, and computes a score for the document. TF (term frequency) of a word is how many times that word appears in the document.

$$TF(t) = \frac{\text{(the number of times term } t \text{ appears in a document)}}{\text{(the total number of terms in a document)}}$$

IDF (inverse document frequency) of a word measure how significant that term is across the entire corpus.

$$IDF(t) = \log_e(\text{total number of documents} / \text{number of documents containing term } t)$$

To calculate the similarity of the formed vectors, several methods can be used: cosine similarity, Euclidean distance, and Pearson's correlation. Once the similarity scores from the document matrix are generated, sorting can be performed based on these scores to create recommendation items.

4) *Results*: The following are the results of the calculations used to determine the index values for each criterion in the Intelligent Job Matching model: Table II Criteria Values, Table III Competency Test, Table IV Skill Test, Table V Knowledge Test, and Table VI Personality Test.

TABLE II
CRITERIA VALUES

Competency Test	0.075
Knowledge	0.168
Skills	0.207
Personality Holland	0.550

TABLE III
COMPETENCY TEST

Less	0.124
Sufficient	0.154
Good	0.316
Excellent	0.406

TABLE IV
KNOWLEDGE

Less	0.128
Sufficient	0.222
Good	0.269
Excellent	0.381

TABLE V
SKILLS

Less	0.100
Sufficient	0.209
Good	0.262
Excellent	0.430

TABLE VI
PERSONALITY HOLLAND

Realistic	0.083
Investigative	0.116
Artistic	0.118
Social	0.162
Enterprising	0.238
Conventional	0.283

5) *Predict Model*: The Predict Model makes classification predictions on a previously trained model. Next, we use this model to predict the labels of the testing dataset (X_{test}) using the predict() function.

6) *Save Model*: After conducting various tests to evaluate the previously created model, the next step is to save the model into a file with the name 'model-intelligent-job matching.joblib'.

III. RESULTS AND DISCUSSION

This is an intelligent job matching model based on Machine Learning that can be accessed online through a website. It is developed from theories of Intelligent Job Matching that are integrated with Machine Learning. The model for Intelligent Job Matching based on Machine Learning can be seen in Figure 2.

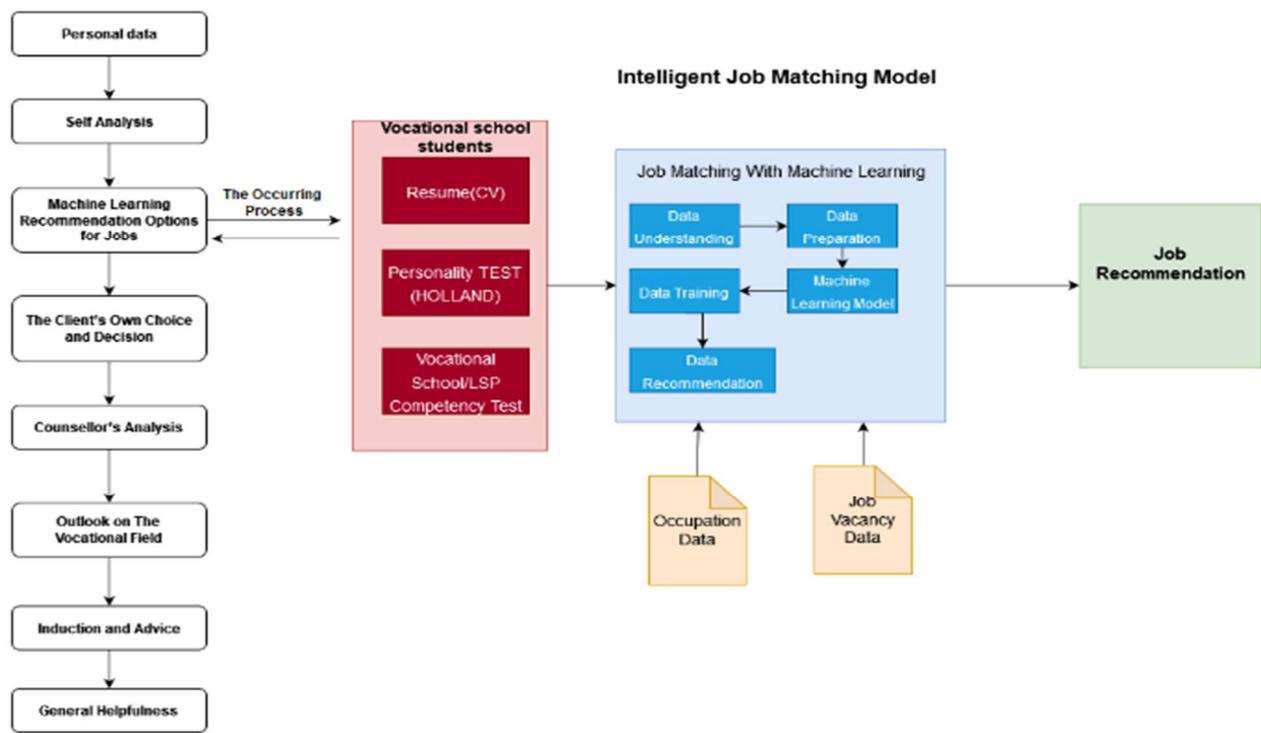


Fig. 2 Model Intelligent Job Matching

Figure 2 shows the existing Intelligent Job Matching Model compared to the Intelligent Job Matching Model that will undergo development. In the first model, matching applicant data with the chosen job field is based solely on the resume or personal data. In contrast, in the model to be developed, the matching of applicant data is based on three components: the resume or personal data, the results of a Personality Test, and a Competency Test. Additionally, Machine Learning is applied based on the data from these three components.

The application of Machine Learning produces job recommendations based on the data from these three applicant

components. The job recommendations provided align with the Occupational Map rules and are used to map job types or professions across various fields of work. After obtaining students' results, the job matching process is a crucial stage in assisting students in directing their careers. It involves comparing students' abilities, interests, and achievements with the requirements and characteristics of jobs in the industrial world. The results of this matching, reflected in the occupational value in the intelligent job matching model, can provide valuable guidance for students in choosing a suitable career path. Further information about occupational values can be found in Table VII.

TABLE VII
OCCUPATION IN INTELLIGENT JOB MATCHING

Index	NISN	B01	B02	B03	B04	B05	B06	B07	B08	B09	Occupation
0	53033124	5	4	10	11	42	18	90	25	23	Programmer Assistant
1	49947482	5	4	9	8	42	18	88	26	23	Programmer Assistant
2	46750692	4	4	9	9	40	20	88	25	22	Programmer Assistant
3	35378125	5	4	9	10	40	20	86	26	22	Programmer Assistant
4	53236375	5	4	8	8	38	18	86	26	20	Programmer Assistant

After obtaining occupational scores based on students' test results, the next step is to match them according to the occupation in the intelligent job matching index, as outlined in Table VIII. This step allows for a more in-depth comparison of students' preferences, skills, and interests with the requirements and characteristics of various jobs within the intelligent job-matching system. Therefore, this process can assist students in determining the career path that best aligns with their profiles, opening up relevant and beneficial opportunities in the professional world.

TABLE VIII
OCCUPATION CODE IN INTELLIGENT JOB MATCHING

Occupation	Occupation Code	Occupation
Occupation	6	Programmer Assistant
Programmer Assistant	5	Network Technician
Network Technician	3	Junior Programmer
Junior Programmer	0	Accounting and Finance
Accounting and Finance	1	Architecture
Architecture	2	Biology
Biology	4	Chemistry
Chemistry	7	Literature
Literature	8	Library and Information

The Subplots.AxesSubplot from "occupation" in the Intelligent Job Matching model provides a proper visual representation for understanding the relationship between career preferences and students' abilities. Using subplots, we can visualize various aspects of occupational data in more detail, as seen in Figure 3. This helps identify patterns and

trends that may exist in job-matching results and facilitates using this data to provide more accurate and personalized recommendations in the context of student career development. Subplots.AxesSubplot becomes a valuable tool in the analysis and decision-making process within Intelligent Job Matching.

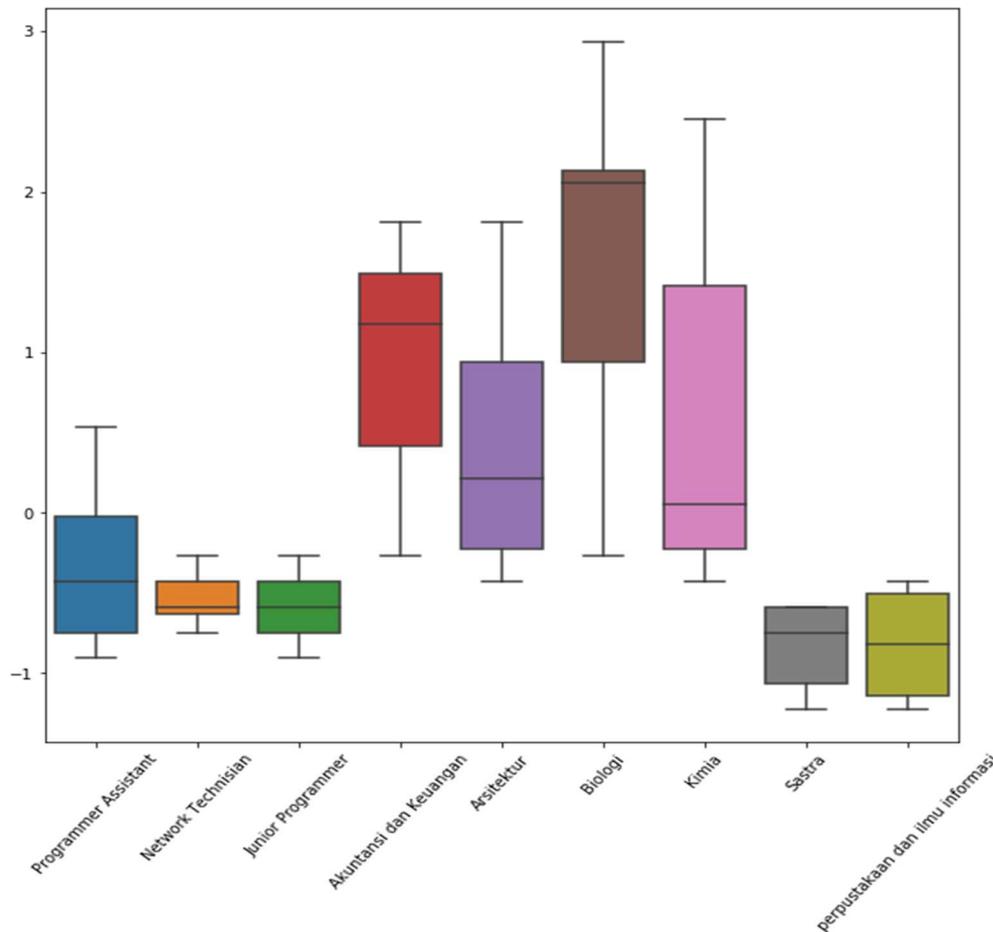


Fig. 3 Graph Intelligent Job Matching model

After students complete a series of exams, including the Competency Test, Skill Test, Knowledge Test, and Personality Test, the next step is to process these results to match the most suitable jobs with their profiles. The matching process combines information from various exams to determine jobs that align best with students' abilities, knowledge, skills, and personalities. The outcomes of this process are then presented in an easily readable format for the students. In this display, students will find job recommendations sorted by ranking, as seen in Table IX. This provides clear guidance to students regarding the jobs that are the most fitting for them and assists them in making more informed career decisions.

TABLE IX
RECOMMENDATIONS FOR INTELLIGENT JOB MATCHING

Rank	Company	Score
1	Company B	0,366202
2	Company E	0,342721
3	Company C	0,293221
4	Company A	0,282076
5	Company D	0,182005

After students receive job recommendations through intelligent job matching, they can use these recommendations as references when applying for jobs that align with their results. This process aids students in directing their steps toward seeking employment that matches their profiles and enhances their chances of success in the professional world. These recommendations are crucial in guiding students toward career paths that align with their abilities and interests.

IV. CONCLUSION

The developed Model of Intelligent Job Matching produces recommendations in the job matching process. This model benefits graduates by providing job recommendations aligned with their profiles and offers advantages to the job market. By implementing the Model of Intelligent Job Matching in the recruitment process, applicants with job qualifications can be matched effectively. Subsequently, after students receive job recommendations through intelligent job matching, they can use them as guidelines for applying to jobs matching their results. This process helps students direct their steps toward

finding jobs that align with their profiles, ultimately enhancing their chances of success in the job market. Thus, the recommendations provided by the Model Intelligent Job Matching play a crucial role in guiding students toward career paths that align with their abilities and interests.

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