

Python- Based Employment Recommendation System Through Predictive Analysis

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Abstract— Data analytics is especially convenient when it comes to fields that gathers a lot of data. It is analyzing unevaluated data in order to make conclusion with the gathered information. In able to interpret the descriptive statistics of the data acquired from the ECE graduates, the accumulated grades starting from 1st year up to 5th year will be characterized into four major subject of the board examination which are Electronics Engineering, Mathematics, Electronics Systems and Technologies, and General Engineering and Applied Science, the grade result of the four main subject from Electronics Engineering Board Examination, and also the acquired results from the self-assessment test. The evaluated data will be used in developing a database management system that gives recommendation of entry level position based on the required skills and qualifications of different companies. This will also provide a report generation system that includes the results with corresponding descriptive and statistical analysis. These analyses will be found inside the employment decision support system that the users will access. The employment decision support system will help assess the users' capabilities and performances and will serve as reference for the employer and the applicant of the job itself.

Keywords— Self- assessment, Employment, Data Analytics, Decision Support System, Entry Level Positions

I. INTRODUCTION

Gathering and correlation of relevant data is the main concept of Decision Support Systems (DSS) which will provide possible studies or understanding. It must provide the users with a sensible solution to gain trust in the system and how the system can help them in any assessment. [1] Some decision support systems are developed because of learning based solutions and improvement of evaluating personalities. One of those is the self-assessment that become an issue over the years because of being automated and can assist individuals privately. [2] It also surrounds in the concept of providing questions to be answered by a number of people then, the response gathered will be generated to come up with a result that will promote enhancement and motivation to the users.

Since industries around the world consist of a wide variety of fields and specializations, decision support systems help managers in control and to be responsible for monitoring, reviewing, and distributing databases to other organizations. This serves as motivational advancement in the industry in

finding more sensible solutions in manipulating results and gain trust in using a system. [1] The process involves stages like computations, communications and some other practical applications that will seek the importance of performance and self- assessment of an individual to be considered as qualified. [3] This structure may expand competition between the applicants, diversify the recruitment of manpower, and demand high standing individuals. [4] In general, many people are having a struggle to find the most suited job for them. Specifically, since Electronics Engineering has a lot of fields to offer, many fresh graduates are confused to what career path is perfect to the skills and knowledge these aspiring Electronics Engineers are equipped with.

As a solution to the problem, in this paper, the researchers proposed to develop an employment decision support system using data analytics. The researchers specifically aim to: (1) To design an employment decision support system that will provide recommendations for ECE students including the specialization and entry level positions; and (2) To create a website accessible to the ECE students for profiling and report generation system. The system promotes an authentication of a document that soon may be used as a reference of the qualifications of the person by recording any set of data and be evaluated to generate results based on the needs of the employer to the job being applied. This can also help in showing the strengths of a person due to its performances and it can assess how much this person is being qualified for that position. This will become a better way to attain quality workers within the industry that will lead to the main goal of the study to provide recommendations including the specialization and entry level positions for ECE students to be able to develop an employment decision support system by means of data analytics.

Since the study is primarily concerned with evaluating a group of people in the same field, particularly in the electronics engineering field, this will include data gathering that is connected to the profession such as academic grades, board examination results, customized self- assessment test depending on the requirements set by the employer or within the company. This document will become legitimate as it is being notarized in the blockchain that will also help in the security of the whole system together with the information stored in the databases.

This type of method is only applicable to a certain field or fields that has the same qualifications. Nevertheless, this will

be reconstructed into a form that suits other fields and soon may solve problems regarding employment. The data gathered will expand the progression of the functionality of blockchain technology and data analytics that has been reliable in the modern days and plays an important role in the public. Compared to the traditional way of manual evaluation, this will help in giving assistance to the employer in recognizing aptitude and knowledge of an applicant determined for the position.

The paper is presented as follows: Section II pertains to the literature reviews of topics that are associated in the study, Section III defines the methods used by the researchers in evaluating the system, Section IV involves the results and the graphical representations based on the responses of the users, Section V explains the accuracy of results found on the conclusion, and Section VI states the recommendation for future works of the research.

II. LITERATURE REVIEWS

A. Employment

The main problem of employment around the world is about job mismatching. [5] This can be a hindrance in achieving high- quality individuals because of incorrect placing of profession and other job functions. [6] As finding the right person to the right job has become one of the important challenges of many companies. [7]

In [5], the researcher observed is a growing gap between supply and demand in the Canadian engineering job market. Kabir proposed about the potential of a paradigm shift in decreasing education-job mismatch. By producing practical entrepreneurial engineering graduate in parallel to scientific engineering graduates, the Canadian education-job mismatch can be decreased.

In [6], the researcher aimed to guide the students in choosing the correct profession by educational activities. It also aimed to conduct a reasonable career planning to improve the skills in employment.

Chen *et al* proposed to used self-awareness, communication and cooperation ability, cognitive ability, and individual reliability as the structure of college students' employment ability to put forward in the study through empirical method.

B. Decision Support System

Decision making processes contain large amount of data that must be generated to give information to its users. The decisions support system (DSS) was created to handle these evaluations properly and systematically. [8] It is also a tool that may be a combination of both automatic and manual. [9] Automatic decision support systems have attributes of consistency, agility, reduction of time, and cost of making manual decisions. It is used to guide the users that the collected data can make determinations on the result of the assessment. Manual decision making is only required when decisions are partially automated then it is the time that is can send alerts. It is always part of the automated decision making because its application is to effectively generate the useful solutions in

spreading information in any fields that needed a support system. [8]

Nowadays, modern decision support systems are developed in web or computer technologies to be capable of the creation of models, evaluation, and predictive results. [9]

In [10], the study is about a decision support system using Adaptive Neuro-fuzzy Inference system (ANFIS) in classifying employees by analyzing the information of each applicant. Acquiring the information of each applicant then filtering and normalization of data were performed.

Žunić *et al* used 2 ANFIS network in classifying candidates in employment gives a satisfactory result. Using different ANFIS network can be a credible endorsement to employers for the suitable employee.

Meanwhile, Nasriyah *et al* proposed A web-based decision support system for assigning employees to their next position through the company's standard that has been set. [11]

In [12], the researchers constructed a decision support system using Adaptive Neuro Fuzzy Inference System, which is a kind of artificial neural network. The data that are gathered from the employee selection process is used as training data of the network.

Moon *et al* proposed a Decision Support System for product-positioning and design that is based on market data and design parameters. The system possesses the security, data integrity, and reliability of a database server, and powerful analytical functions of MATLAB. [13]

In [14], the researchers also proposed a Decision Support System for the application of a new model of predictive police patrolling for the effective distribution of police officers in a certain place that is under the jurisdiction of a police department, with the aim of reducing the probability of criminal acts.

TABLE I
BRIEF COMPARISON FRAMEWORK OF THE RELATED WORKS

Authors	Method Used to create DSS	Function	Target Field
E. Žunić, A. Djedović and Z. Avdagić (2016) [6]	Adaptive Neuro-fuzzy Inference system (ANFIS)	For classifying employees.	Employment
R. Nasriyah, Z. Arham and Q. Aini (2016) [7]	Web-based	For assigning employees to their next positions.	Employment
A. A. Indrawati and Sri (2018) [8]	Adaptive Neuro Fuzzy Inference System	For selecting employees	Employment
N. L. Moon and S. Ki (2014) [9]	MATLAB	For product-positioning and design	Business / Marketing
M. C.-C. a. F. Liberatore (2015) [10]	Web-based	For the effective distribution of police officers.	Security Purposes

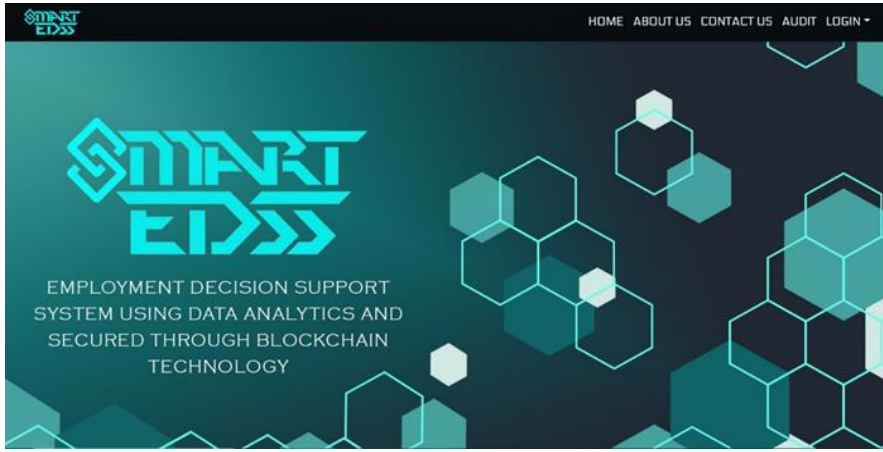


Figure 1. Smart EDSS Home page

Figure 2. Smart EDSS Login

Table I shows the comparison of the study to other related works where it revolves around the target field of employment.

C. Self- Assessment

Formative self-assessments are autonomous that can be beneficial to the promotion of students' learning ability. [2] It can be a tool in testing or will serve as an accredited device for personal self- monitoring. [15] There are just some worries about self-assessments because it tests one self's critical thinking skill and the challenge for incompetency. Effectivity can be carried out by providing guidance and trainings. [16]

Some assessment offers numerical scales, model and checklist that can connect to each question and analyze it afterwards. [17] Surveys may contain estimations at a scale one to four with different equivalent per number (e.g. 1. Not at all, 2. Poorly, 3. Quite well, 4. As well as possible). This scale is modified by Bloom's Taxonomy that states that by asking the number of times student has used that item in programs will indicate the number of repetitions to increase the depth of knowledge. [18] This will indicate the performance of how well the person answer towards the situation stated on the question. Mostly, these assessments are also built by using algorithm to come up with a certain result based on the objective of the study or research. An example of an algorithm to estimate the students' knowledge level is by considering these steps: (1) Choosing and determining the best item to ask, (2) The response of the student on the question asked, (3) The new estimation of the student's knowledge level that is developed based on the response will be computed, and (4) System will repeat steps until the criterion is met. [19]

Present software systems that conduct testing take into consideration if the interface is user friendly to the data subject, automatic recording of results, formation of test protocol, etc. In example, the primary use of computer technology in assessing the student's achievements is to reduce the chances of cheating, increase productivity of instructors and increase control measures in order to correct errors and quickly respond to the competency of every student. This is an innovative way to implement effective assessment and testing process such as using various types of questions, storage of results and organized user interface, and to cope up with advanced technology. [20]

D. Data Analytics

Data Analytics is the method of analyzing sets of data to come up with conclusions regarding the information that it

must accommodate by the application of using a software and specialized systems. [21] It is also relevant in generating facilities in smart cities, third party auditors and avoiding centralized dependency. [22]

It can be classified into qualitative data analysis and quantitative data analysis. Quantitative analysis deals with the evaluation of numerical data with quantifiable variables that can be calculated statistically. Qualitative analysis is more interpretive - it deals with the understanding of non-numerical data like image, audio, text, and video. [21]

III. METHODOLOGY

Employment Decision Support System

1. Web Design

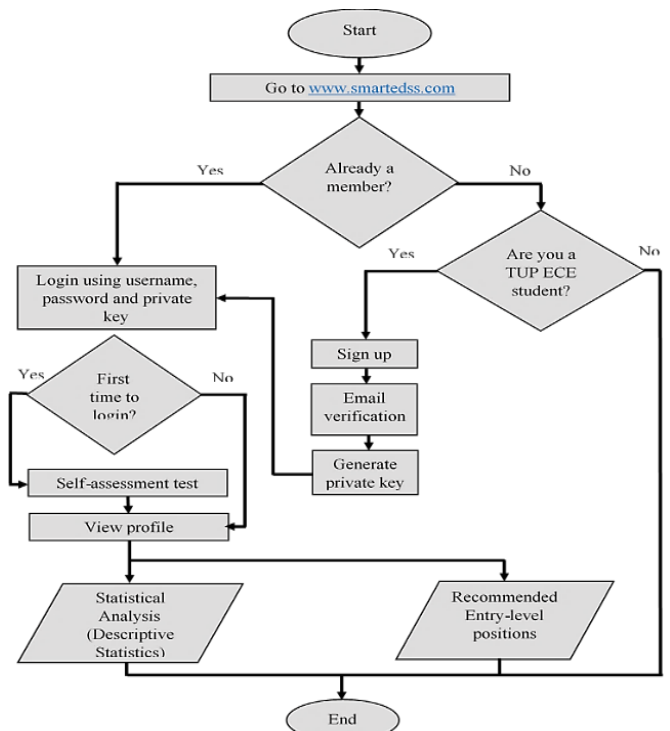


Figure 3. System Assessment Flow Chart

Figure 3 shows the processes involved in using the system. The new users need to follow the flow chart including the steps indicated in Figure 4 for the evaluation processes.

The web design consists of the following parts:

(1) Home

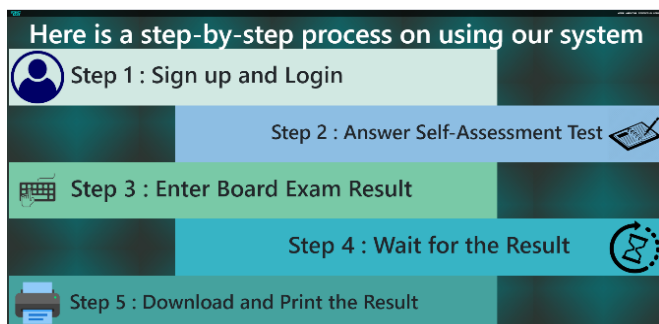


Figure 4. Smart EDSS step-by-step process

(2) About Us

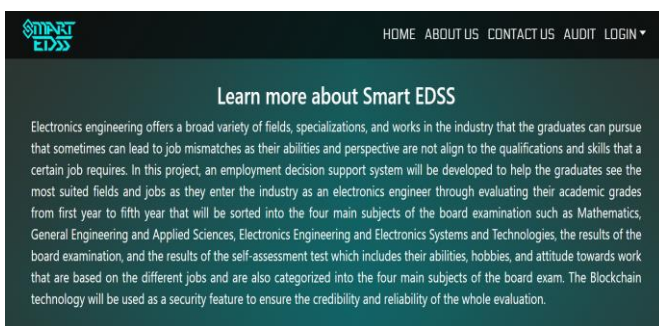


Figure 5. About Us page

(3) Contact Us

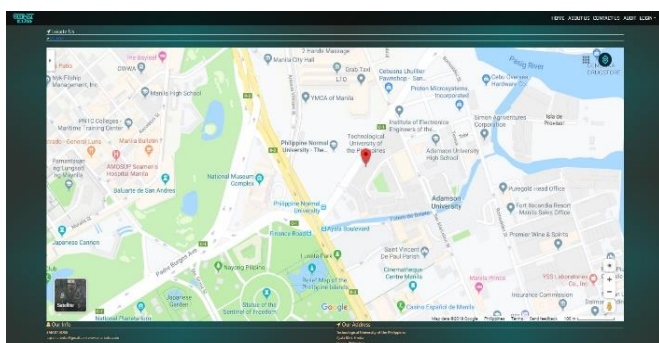


Figure 6. Contact Us page

(4) Login/ Sign up

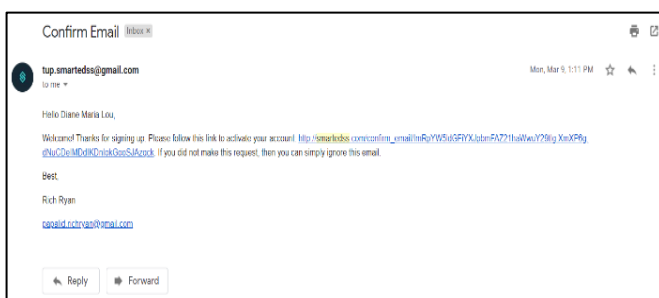


Figure 7. Email Verification

(5) Audit

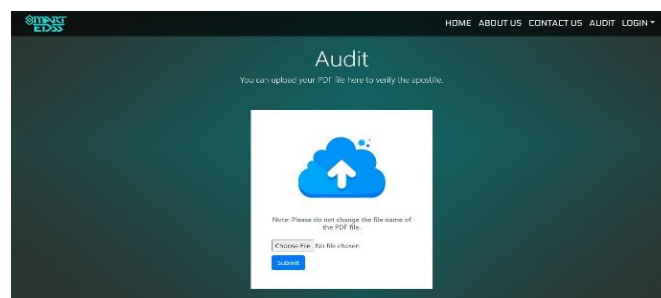


Figure 8. Audit Page

Figure 8 shows the Audit page where the users can verify if the downloaded PDF file is already stored in blockchain.

(6) User Profile

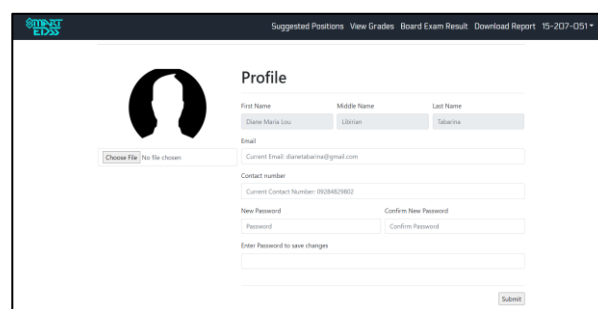


Figure 9. Edit Profile Page

The display on the home page of the system is shown in Figure 1 and Figure 4. Then, Figure 2 and Figure 7 shows the login/ signup process where users fill up information and receive the verification mail. Figure 5 explains the idea of the page and Figure 6 shows the contact us page. Figure 8 is the audit page to check if files are already stored in blockchain. Lastly, Figure 9 shows the edit profile page.

2. Process of Evaluation

The evaluation of the employment decision support system for the recommendation of entry level positions considered the following factors:

2.1 Academic Grades (35%)

The academic grades provide the performance of every graduates based on the subjects present in the curriculum. Those subjects were categorized into its respective board exam subjects using the Table of Specifications (TOS) which can be found on the PRC website. Based on the categorization, the corresponding grades under the four (4) board exam subjects will undergo statistical analysis where the percentile and general average were computed.

$$\%Board\ Exam\ Subject = \frac{\sum(Grades \times No. \ of \ Units)}{Total \ Number \ of \ Units} \times 35\%$$

2.2 Board Examination Results/ Ratings (35%)

Second factor is the board examination ratings. In ECE board examination, the four (4) subjects such as Mathematics, General Engineering and Applied Sciences, Electronics Engineering, and Electronics Systems and Technologies, has

separate percentages as shown in Figure 10. This factor will test the mastery of the graduates on the knowledge that they have learned in their college years that will be helpful for their future jobs.

Percentage (results) x 35%

BOARD EXAM RESULTS	
Subjects	Grades
Electronics Engineering	85.00%
Electronic Systems and Technology (ESAT)	77.00%
General Engineering and Applied Science (GEAS)	75.00%
Mathematics	80.00%

Figure 10. Board Exam Ratings

2.3 Self-Assessment Test (30%)

2.3.1. Skills/ Interests/ Hobbies Test (15%)

2.3.2. Personality and Situational Test (15%)

The self-assessment test is divided into two parts: (1) Skills/ Interests/ Hobbies Test, the sixteen questions provided were related to what hobbies, tasks, and skills does an electronics engineers have. The questions were equally categorized into the four subjects of the ECE board examination. The users will then rate the questions, 1 as the lowest and 5 as the highest, based on their preferences. (2) Personality and Situational Test is composed of twenty-two questions that will examine the graduates' attitude and work ethics. The questions were customized by the researchers based on the qualifications required by different companies. The users will also rate the questions, 1 as the lowest and 5 as the highest

Note: 1 = 60%, 2 = 70%, 3=80%, 4 = 90%, 5 = 100%

Rating Scale					
	Very Poor	Poor	Average	Good	Very Good
Question 1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Question 2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Question 3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Total	0.00				

Figure 11. Self- Assessment Scale

Most companies use psychological tests in hiring and based on Figure 11, this is the most common scale that self-assessments contain to evaluate the answers of the users depending on the questions given.

The researchers were able to research fourteen (14) ECE entry level positions with its corresponding descriptions and qualifications. These qualifications were also categorized into the four subjects of the board examination. The basis of the categorization is on what subject/s a certain skill/qualification can be learned. The weights per job as shown in Table II were obtained through dividing the number of job qualifications that went under Math/GEAS/ELEX/ESAT by the total job qualifications given, then multiplied with 100% which is:

$$\frac{\text{Number of job qualifications under a subject}}{\text{Total number of job qualifications}} \times 100\%$$

TABLE II
WEIGHT OF THE JOBS

Jobs	Math	GEAS	ELEX	ESAT	Total
Cadet Engineer (Microelectronics Industry)	325/42	175/6	275/6	725/42	100
Cadet Engineer (Telecommunications Industry)	125/12	175/6	75/4	125/3	100
Process Engineer	35/3	100/3	140/3	25/3	100
Planning Engineer (Microelectronics Industry)	115/6	175/6	235/6	25/2	100
Planning Engineer (Telecommunications Industry)	125/11	725/33	725/33	1475/33	100
Procurement Engineer	30	50	15	5	100
Support Engineer	175/36	475/36	1475/36	1475/36	100
Network and Service Engineer	800/39	950/39	950/39	400/13	100
Site Acquisition Engineer	475/36	275/12	575/36	575/12	100
Circuit Designer Engineer	400/33	400/33	1750/33	250/11	100
Failure Analysis Engineer	125/18	175/6	325/6	175/18	100
Data Analyst/Scientist	275/6	475/18	125/18	125/6	100
Instructor/Professor/Academe	175/6	325/18	475/18	475/18	100
Quality Assurance Engineer	175/33	925/33	1525/33	225/11	100

TABLE III
OVERALL COMPUTATION

	Grades	Board Exam	SA 1	Weight
Math	[(G x 35%) + (P x 35%) + (Q x 15%)] x (weight of the job)			
+GEAS	[(G x 35%) + (P x 35%) + (Q x 15%)] x (weight of the job)			
+Elecs	[(G x 35%) + (P x 35%) + (Q x 15%)] x (weight of the job)			
+ESAT	[(G x 35%) + (P x 35%) + (Q x 15%)] x (weight of the job)			
+SA 2	(questions percentage/no. of items) x 15%			

Table III shows the process of the overall computation of the system. The percentages gathered to the said factors, such as Academic Grades, Board Exam Results, and Self-Assessment Results were added by subjects.

The calculations will be performed on all the fourteen jobs by adding up the percentages (per subject) obtained with the three factors presented then multiplying it to the weight obtained (per subject) on each job. The top three jobs with the highest total scores will be the suggested entry level positions for the users.

```
import sqlite3 as sq
import operator

db = sq.connect('database.db')
cur = db.cursor()
cur.execute('SELECT cadet_engr_micro, procure_engr, process_engr,
plan_engr_telecom, supp_engr, network_engr, cadet_engr_tele,
plan_engr_micro, site_acq_engr, fail_anal_engr, ckt_design_engr,
QA_engr, data_anal, profession FROM job_score WHERE (student_id=?)', [student_id])
scores = cur.fetchone()

cadet_engr_micro = ((325/42) * math_total + (175/6) * geas_total + (275/6) * elex_total + (725/42) * esat_total) + scores[0]
procure_engr = (30) * math_total + (50) * geas_total + (15) * elex_total + (5) * esat_total + scores[1]
process_engr = ((35/3) * math_total + (100/3) * geas_total + (140/3) * elex_total + (25/3) * esat_total + scores[2])
plan_engr_telecom = ((115/6) * math_total + (175/6) * geas_total + (235/6) * elex_total + (25/2) * esat_total + scores[3])
plan_engr_micro = ((125/11) * math_total + (725/33) * geas_total + (725/33) * elex_total + (1475/33) * esat_total + scores[4])
supp_engr = (30) * math_total + (50) * geas_total + (15) * elex_total + (5) * esat_total + scores[5]
network_engr = ((800/39) * math_total + (950/39) * geas_total + (950/39) * elex_total + (400/13) * esat_total + scores[6])
cadet_engr_tele = ((125/12) * math_total + (175/6) * geas_total + (75/4) * elex_total + (125/3) * esat_total + scores[7])
site_acq_engr = ((475/36) * math_total + (275/12) * geas_total + (575/36) * elex_total + (575/12) * esat_total + scores[8])
fail_anal_engr = ((400/33) * math_total + (400/33) * geas_total + (1750/33) * elex_total + (250/11) * esat_total + scores[9])
ckt_design_engr = ((400/33) * math_total + (400/33) * geas_total + (1750/33) * elex_total + (250/11) * esat_total + scores[10])
QA_engr = ((175/33) * math_total + (925/33) * geas_total + (1525/33) * elex_total + (225/11) * esat_total + scores[11])
data_anal = ((275/6) * math_total + (475/18) * geas_total + (125/18) * elex_total + (125/6) * esat_total + scores[12])
profession = ((175/6) * math_total + (325/18) * geas_total + (475/18) * elex_total + (475/18) * esat_total + scores[13])

jobs_list = ['cadet_engr_micro', 'procure_engr', 'process_engr', 'plan_engr_telecom', 'supp_engr',
'network_engr', 'cadet_engr_tele', 'plan_engr_micro', 'site_acq_engr', 'fail_anal_engr', 'ckt_design_engr',
'QA_engr', 'data_anal', 'profession']

jobs_score = [cadet_engr_micro, procure_engr, process_engr,
plan_engr_telecom, supp_engr, network_engr, cadet_engr_tele,
plan_engr_micro, site_acq_engr, fail_anal_engr, ckt_design_engr,
QA_engr, data_anal, profession]
```

Figure 12. Python Code for the Computation of the Evaluation

Figure 12 shows codes for implementing the evaluation of the whole system. From the calculations of grades categorized in four main subjects to the assessment test, this system generated the results using Python as the programming language.

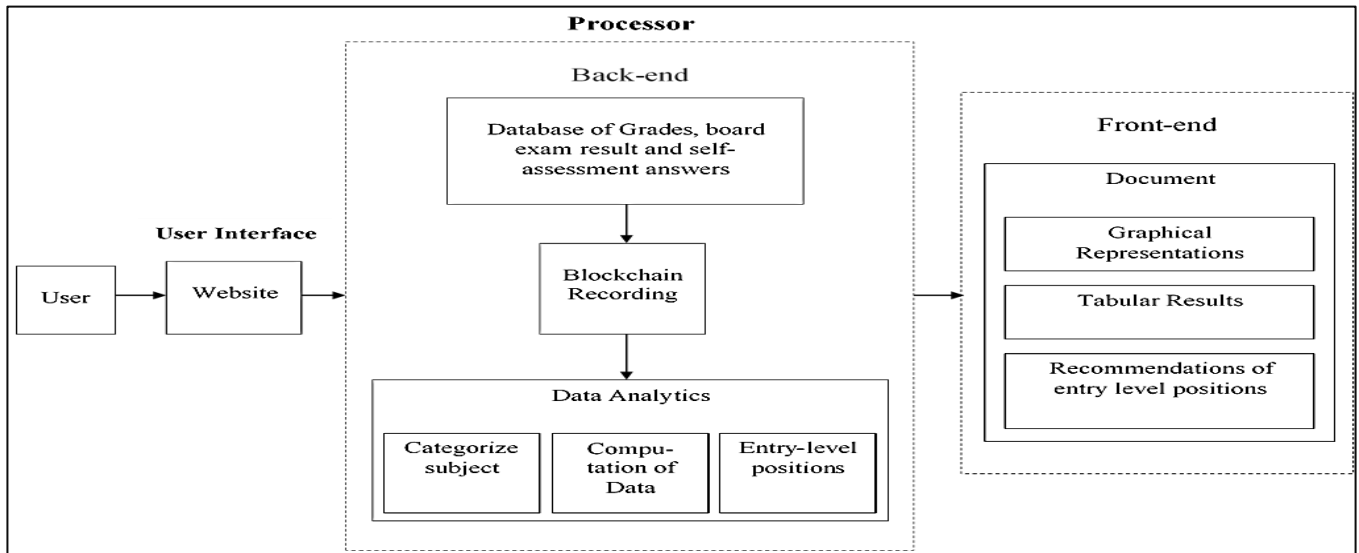


Figure 13. Block Diagram of the System

3. Report Generation System

The report generation system provides the results shown in both the system and the downloaded file.



Figure 14. Smart EDSS Results

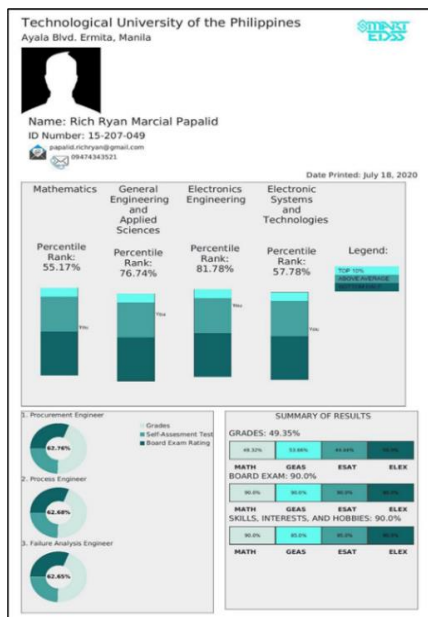


Figure 15. PDF file of the Results

Figure 13 shows the block diagram of the system that indicates the perspective from the user accessing the website to the processes done at the back- end and the displayed contents through the front- end.

Figure 14 provides the result of the evaluation from the assessment of grades, board exam ratings and self-assessment test through graphical representation. It also indicates the top 3 entry level job recommended with job descriptions below. Then, it will be converted into a PDF file

Figure 15 is the PDF file format. It contains information about the profile of the user like a resume, the summary of results of all percentages and the recommended entry level positions with corresponding job qualifications.

IV. RESULTS AND DISCUSSION

TABLE IV
TALLY OF RESULTS

Jobs/Positions	Tally
Data Analyst	15
Procurement Engineer	17
Instructor	9
Site Acquisition Engineer	11
Microelectronics Planning Engineer	4
Telecommunications Planning Engineer	9
Microelectronics Cadet Engineer	1
Telecommunications Cadet Engineer	9
Circuit Design Engineer	4
Process Engineer	8
Failure Analysis Engineer	5
Quality Assurance Engineer	2
Network and Service Engineer	0
Support Engineer	5

Table IV shows the tally of results gathered from the evaluation of 31 participants. Each of the subjects has the top three recommended jobs or positions evaluated by the employment decision support system using data analytics by having the users' academic grades, board exam results, and self-assessment test results as data.

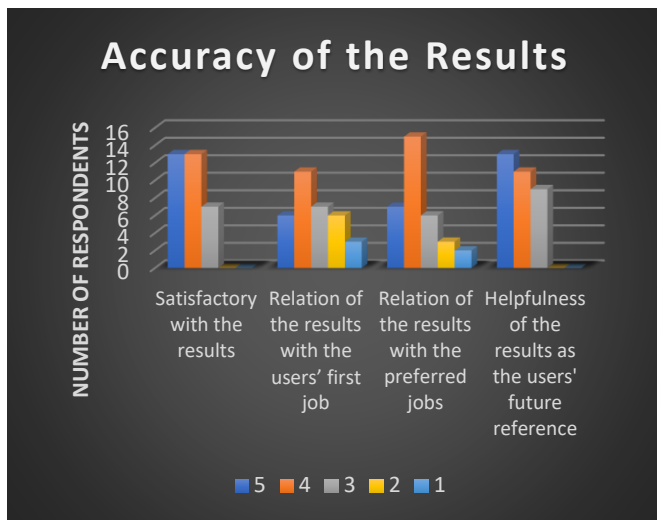


Figure 16. Accuracy of the Results

Figure 16 shows the summary of the users' evaluation on the accuracy of the results. The evaluation as shown on the graph has four factors to consider such as (1) satisfactory with the results, (2) relation of the results with the users' first job, (3) relation of the results with the preferred jobs, (4) helpfulness of the results as the users' future reference, and were rated, 5 as the highest and 1 as the lowest. The averages of the ratings per factors are 91.52%, 82.12%, 86.06%, and 90.91%, respectively.

Note: 1 = 60%, 2 = 70%, 3=80%, 4 = 90%, 5 = 100%

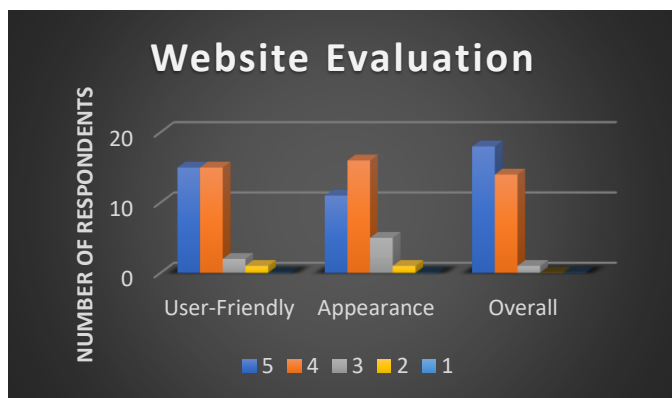


Figure 17. Website Evaluation

Figure 17 shows the summary of the evaluation on the website. Considering factors are (1) how user-friendly is the website, (2) the appearance of the website, (3) the website's overall features. The averages of the ratings per factors are 93.33%, 91.21%, and 95.15% respectively. Clearly, the data show that majority of the users were satisfied with the website's appearance, system's overall procedures and features.

Note: 1 = 60%, 2 = 70%, 3=80%, 4 = 90%, 5 = 100%

V. CONCLUSION

With the application of data analytics in employment decision support system, the averages show that majority of the users were satisfied and were certain that the results are going to be helpful for their future career plans. However, few participants have low ratings mainly because, according to the graduates, the results did not match their current jobs as these positions were the opportunities easily given to them after graduating. Moreover, given their situations, these graduates were decided to enhance and to sharpen their skills and knowledge with their chosen career paths.

VI. FUTURE WORKS

This research may be developed by considering other fields that wants to improve the employment process and utilize this system depending on the evaluation needed. Some universities may adapt this method to give guidance to students and serve as future reference. This study may undergo many different versions of data gathering on a certain field. Tests and experiments have been left for the future due to lack of time and the study is more focused in a specific field. It is because there are many different professions and questions are being constructed by the researchers. This will take time due to gathering of information, customizing a self- assessment examination then testing and verifying it, and finally being able to check its accuracy and process it within the system's interface.

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