Researcher Evaluation, Assessment, and Database System (READS): An AI-based Performance Analysis

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Abstract

Research is a central function of a university and each faculty has rewarded a chance to undertake it in their preferred field. However, researchers are merely assessed objectively instead of assessing analytically in a way that scores are provided and calculated systematically. Many researches have been conducted to produce for the performance of a researcher. Yet, smarter algorithms are being sought. This study aims to develop an intelligent monitoring framework as a web application for assessing and observing faculty researchers in R&D of various colleges of the Technological University of the Philippines- Manila. Based on the literature review on faculty research performance, specific factors were used as the basis for evaluation. These factors were based on the criteria for the best researcher in the university namely: number of completed projects, research dissemination, patent or copyright certification, utilization of research, research-related awards, educational attainment, and Google Scholar metrics. These factors are given weight to be computed as T-index - the faculty researcher performance indicator. Research priorities or categories are also put into consideration. Subsequently, it was merged into the software system developed. This study became effective in the University deployment and put into good use in University Researcher and Development Services (URDS) Office. The developed web platform helped in recognizing distinguished researchers, level-up their research performance, and unleashed the researcher's potential. Furthermore, the website helped the researcher to monitor their research activity and research field in which they succeeded.

***Keywords*—faculty, assessment , intelligent system, monitoring platform**

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I. Introduction

Nowadays, researchers are assessed objectively instead of assessing analytically in a way that scores are provided and calculated systematically. Numerous researches and projects are being worked and developed, but never got published. Since concluding any projects involves careful arranging, plan, implementation, and up to conveying the outcomes, not all researches are viewed as effective and successful [1]. Also, the national government and some of the granting aids in the Philippines are wasting loads of capital on unsuccessful projects and research. Behind this cause, several considerations need to be addressed when funding qualified research.

Google Scholar platform is the most widely used software that provides and displays the output of various experts in different fields. The ranking methods used by Google Scholar are h-index and g-index that are measured on the total count of citations and influence results for journals [2]. These metrics quantify the impact of the author's released paper from its area of innovation and add up in the average scores of citations of submitted papers by the scientist. Google Scholar system is like the conceptual rating method of this research. However, it is solely determined by the total counts of the faculty's submitted papers. There are numerous scholarly and educational publications in the country that are not well known due to its old system and not updated on modernization [3]. Since several papers that are published in the Philippines

and a system that allows to open and recognize it is not yet available, it is difficult to obtain high-standard local published papers that meet international standards. Only researches that has undergone peer review might be plagiarized.

This study aims to develop an intelligent monitoring framework as a web application capable of assessing faculty researchers in R&D of various colleges of the Technological University of the Philippines- Manila. Monitoring the faculty research output is one of the bottleneck in the university system. This framework will automate the assessment of the faculty researcher and helps to grant research to qualified researchers and institutions through the implementation of the scoring system. Specifically, this study aims to develop a database management system for the university's research and different analytics modules that will integrate to develop READS. These analytics modules include the following: t valuation of every faculty member; the valuation for the R&D of various colleges in the university and the decision support system for granting research.

The results of this study will be of great benefit to the URDS since the platform will critically evaluate faculty who is proficient and has a high chance of success, accordingly. It will also benefit the researcher in monitoring their research activities and to evaluate which research category they excel at. Since this platform will classify the ranks of the researchers, it will affect the competence of every faculty when it comes to research and will help the university in endorsing researchers and their proposals subsequent to demands for government support. Moreover, this study will benefit the university's faculty influence in the research community.

READS shows the ranking list of the qualified faculty in their corresponding colleges and monitors various colleges that input the most in each categorization. The output analysis of the faculty members will be based on the criteria of the best researcher in the university and the input data of this framework is from the research related data of every faculty and college in the university. Furthermore, the platform of this study will concentrate primarily on the rating and classification of faculty researchers. Several conditions that the proponents may have encountered in performing the analysis will not be explicitly discussed and would open to future studies.

II. Related Studies

He Yongqiang developed a study of quantitative models that will evaluate the university researchers' output in an accurate and technical manner [4]. Based on a survey of the achievement assessment, several methods are used to evaluate the university researchers' output such as the quantization index system, the process of changing the qualitative analysis into a quantitative analysis of each index, and developed a quantitative model. Various universities can meet the actual requirements by changing the qualitative definition base of indexes for all stages and its equivalent points, and the equivalent base of the actual and standard number too. Computation of all the bases as well as the whole framework is processed by a computer software design.

A framework for evaluating the faculty with uncertain information due to a complex problem of multiple attribute decision making (MADM) was created by Q.Zhang, et al. [5]. Interval numbers are used in the unclear decision domain to determine the total interest of alternatives to solve a certain problem. In current strategies, some knowledge on the probability of dominance would fail in the procedure of converting interlude numbers to firm numbers that rank and pick faculty candidates. In the current process of converting the resulting numbers to a crisp value, some input would lose that is why a novel approach is planned that will calculate the attributes scores by optimizing measured gap between alternatives and the highest distance of the total scores are computed and for evaluating faculty aspirants, the advantage possibilities are also calculated.

T. Rikakis developed a study that presented an innovative criterion for faculty evaluation and benefiting collaboration [6]. It introduces five groundbreaking approaches that work collaboratively through disciplines in the assessment of engineering faculties. The five practices are: Four-category meta-matrix used to calibrate the stages of assessment; the conventional author is replaced with the collaborators; the collaborators are assessed and rewarded; guidelines for balancing the interdisciplinary and disciplinary factors of collaborators are developed and; the interdisciplinary review for all stages of assessment is conducted. High impact outcomes has been promoted by using the innovative criterion.

A study that expands the academic quality of various colleges and universities' faculty and their degree programs to online development and evaluation was created by K. Dennis [7]. Study-based teaching, coaching, and assessment programs were developed to promote constant development in ICT. Several sessions are presented that used to develop and improve the organizations. The sessions conducted have effective quality measures to evaluate each faculty through an online form.

P. Shah (2015). integrates management in manufacturing engineering study, growth and realization, and identifies key factors in the successful fulfillment of the organization's objectives and provides an important contribution to the

administration [8]. Research and Development findings need to be realized more quickly because the lead-time for R&D is diminishing. This study analyzed the entire process sequence of manufacturing engineering from the phase of testing to the phase when it is completely done. Two case studies are provided, one for the simultaneous growth of material manufacturing and industrial engineering, and the other one is for the expansion of fabrication machinery.

Due to a challenging task of predicting the performance of each faculty, P.Shah, et al., conducted a study that provides a better approach to predicting and analyzing the success of faculty in distributed data mining [9]. Using disseminated data mining, the system can collect information from various origins and then use the algorithm identification. Also, it provides an effective data storage path and thus allows fast and easy access to data. By classifying it can achieve greater quality and precision in calculating faculty results and in different tests, it can build a system that predicts the faculty's output based on their ability, timeliness, and success. WEKA or Waikato Environment for Knowledge Analysis tool, a data mining software to collect machine learning algorithms is used to test the classification technique results accurately.

Previous literatures showed various techniques in measuring the researcher output evaluation. However there is still a need to explore on various methods to properly measure the performance of the university based on its researchers output.

III. Methodology

Figure 1 shows the different valuations of the website together with the parameters for each. The three (3) valuations are Faculty Researcher Valuation, College Valuation, and the Project Grant Valuation.

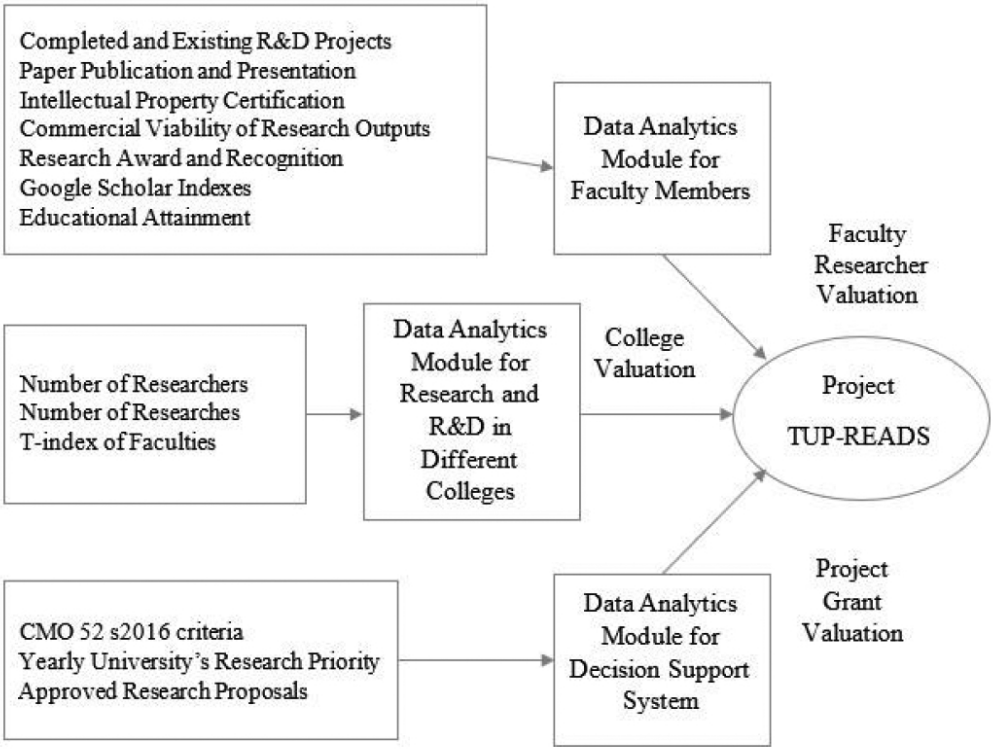


Fig. 1. Conceptual Framework of the Study

A. Data Set

In every valuation there are only specific datasets that have been used. Table 1 shows the total population of faculty researchers of the University, which is 347, and among these faculty researchers, only 16 faculty researchers from the ECE faculty are used to present the accuracy of the Faculty Valuation of the website. Also, a total of 37 faculty researchers from different colleges are used as datasets to present the accuracy of the College Valuation of the website, both from the year 2017. For the Grants datasets, the results from the colloquium 2019 have been used.

TABLE 1
DATASETS USED IN COMPUTING THE COLLEGE AND FACULTY VALUATIONS

Colleges	Faculties	Datasets for Faculty Valuation	Datasets for College Valuation
CAFA	27	0	1
COE	62	16	16
CIE	45	0	6
CLA	55	0	6
COS	54	0	4
CIT	104	0	4
Total	347	16	37

B. Faculty Valuation

The faculty valuation is based on the best researcher criteria of the university. Table 2 shows the parameter of the said valuation.

TABLE 2.
FACULTY VALUATIONS

Criteria	Raw Score
A. Number of Completed and Relevant R&D Projects in the last five years	20
B. Research Dissemination	20
C. Intellectual Property Certification	15
D. Utility and Commercial Viability of Research Outputs	15
E. Research-Related Awards and Recognition	15
F. Google Scholar Metric	10
G. Highest Educational Attainment	5
TOTAL	100

Each category in Table II has a maximum point and in total is 100 points. In the RPAD website, this valuation is displayed by the T-index, Equation 1 will show the formula.

$$T-Index = \frac{Category\ A + Category\ B + Category\ C}{10} + \frac{Category\ D + Category\ E}{10} + \frac{Category\ E + Category\ F + Category\ G}{10} \quad (1)$$

Equation 1 is divided by 10 to suit the name itself, the index means small, the website only displays its whole number and rounds down its decimals. The possible maximum T-index is ten (10) and the minimum is zero (0).

C. College Valuation

The rankings of the colleges in the university depend on the performance of their faculty members. The ranking will be shown on the RPAD website. There are three (3) parameters for the college valuation. Those are the total T-index of the faculties in a specific college, the total research in a specific college, and the total research in the university. Equation 2 shows how those parameters are computed.

$$College\ T-Index = Average\ of\ T-index\ per\ College + \frac{Total\ number\ of\ researches\ per\ College}{Total\ number\ of\ researches\ in\ the\ University} \quad (2)$$

D. Project Grant Valuation

The platform will also serve as a decision support system for granted research. From the CMO-52-s2016 the Grant-in-Aid program is from the Commission and Higher Education (CHED) this will concentrate on stages that depend on the seventeen (17) Sustainable Development Goals (SDGs) but specific attention will be given to the following: a) Food Production and Security, b) Environment, Disaster Risk Reduction, Climate Change, and Energy, c) Terrestrial and Marine Resources: Economy, Biodiversity, and Conservation, d) Smart Analytics and Engineering Innovations, e) Health System, and f) Education for STEAM [9]. The University Research and Development Service Office included another classification which is the g) Social Science. Additional priority areas will be included per year based on the recommendation of URDS. The RPAD will propose various grantors for various research categories.

IV. Results and Discussions

A. Web Page Developed

The website can be accessed by the faculties in the university with "rpad_first name" as their username and "reads" as their default password. Figures 2-6 are the user interface of the platform.

Figure 2 shows the login page of the website where all the information regarding RPAD was displayed, such as READS all about, the different research priorities, and information on how the user can connect to the admin of the website. Also, this page was the way for the user to access the website.

Figure 3 shows the profile page of the website where all of the information of the users were posted such as the name, highest educational attainment, academic position, specialization, grants research, researcher papers and its related awards, publication, paper and poster presentation, IPOs and viabilities of outputs.

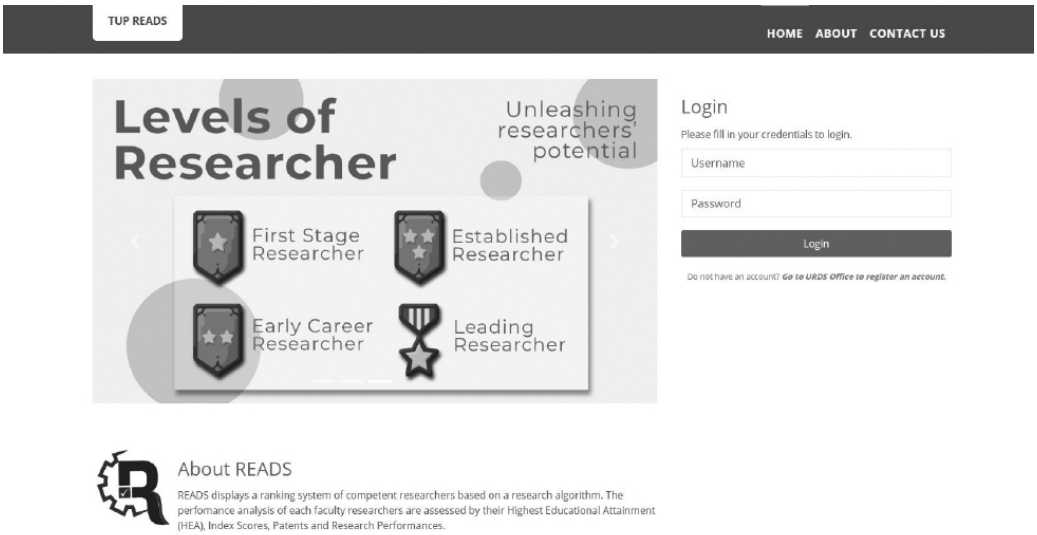


Fig. 2. Login page of READS

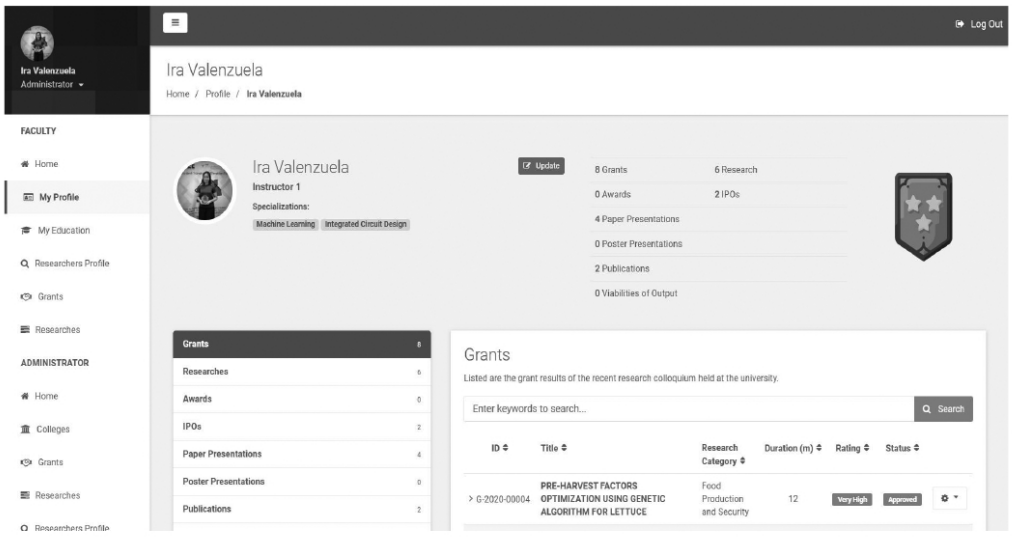


Fig. 3. Profile Page

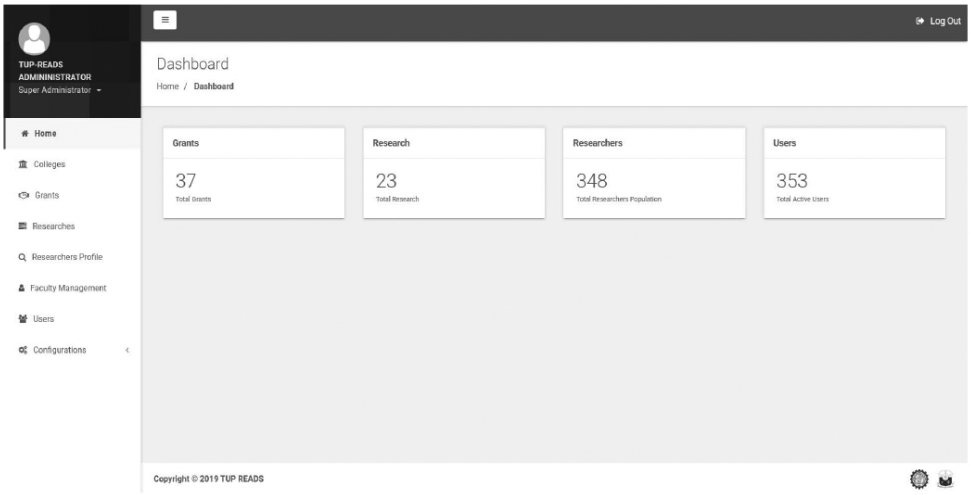


Fig. 4. Admin page of READS

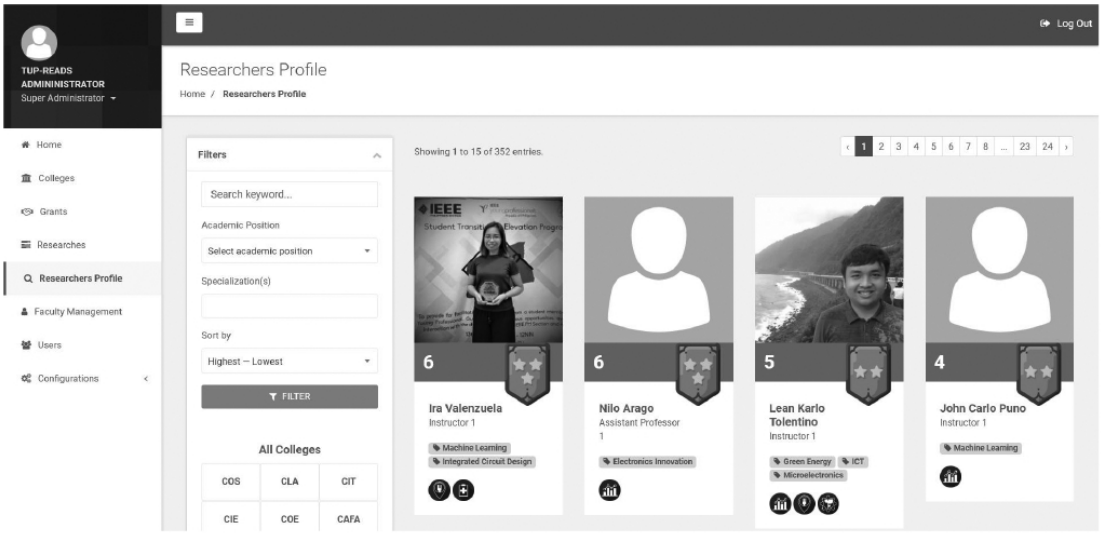


Fig. 5. Researcher Profile Page

Figure 4 shows the admin page where the only person assigned to update and monitor the RPAD has access. This page served as the storage of all the information submitted in the page and the administrator is the one who will determine if the submitted data will be posted in the RPAD page.

Figure 5 shows the add feature for the research proposal. All the information of the proposed research was submitted to qualify it for research granting. This page displayed a fill-up form for all the necessary information of the proposed research. There is a button that automatically categorized the research proposal into its research category based on its title. In the case that the user was not satisfied with the resulting category, a select button for the research category and its sub category is provided. The created research proposals were evaluated and accepted or approved by the administrator to finally be displayed in the user's profile.

Figure 6 shows the researcher profile page where the ranking of faculty researchers based on their T-indexes displayed. This page also had a filter button where the user can sort all of the faculty based on their respective colleges, academic position, school year, research priorities and specialization. Also, it had a button for each college where the user can sort all other faculty researchers based on their respective colleges.

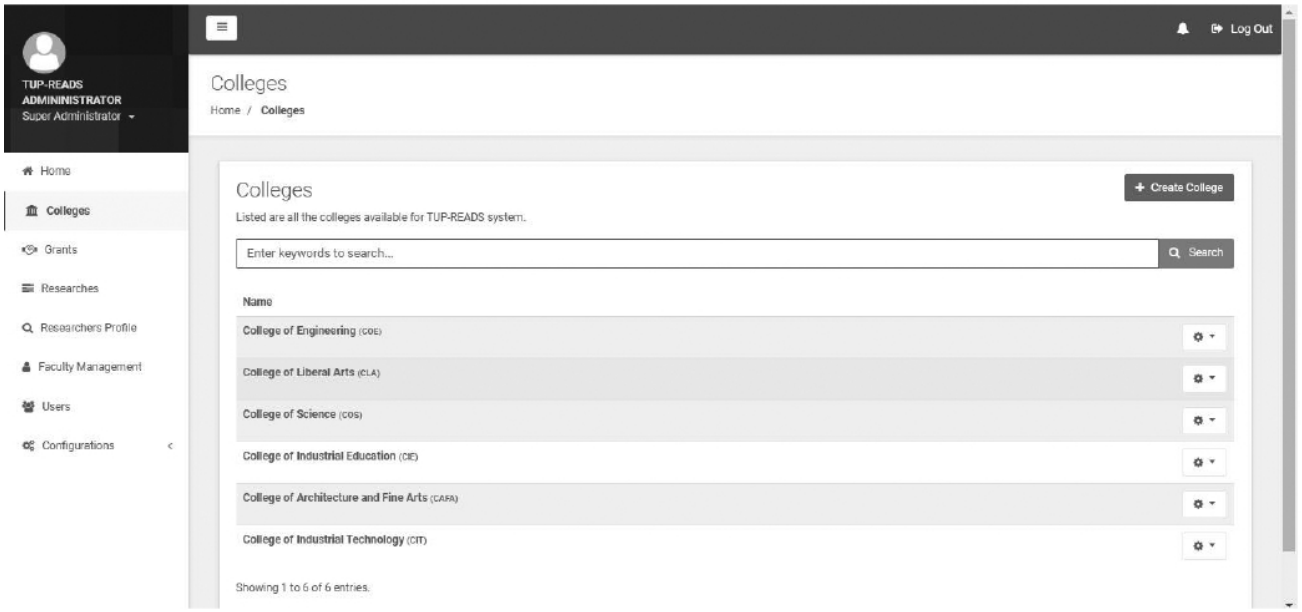


Fig. 6. College Page

B. Analysis and Result of the Faculty Valuation

Table 3 shows the expected T-index of the ECE faculties by manually computing the data of the year 2017. The Category F is not applicable for the year 2017, even though the users have data for that. The platform will also serve as a decision support system for granted research. From the CMO-52-s2016 the Grant-in-Aid program is from the Commission and Higher Education (CHED) this will focus on platforms that are based on the seventeen (17) Sustainable Development Goals (SDGs) and it has clustered the seventeen (17) SDGs into six platforms, namely: a) Food Production and Security, b) Environment, Disaster Risk Reduction, Climate Change and Energy, c) Terrestrial and Marine Resources: Economy, Biodiversity, and Conservation, d) Smart Analytics and Engineering Innovations, e) Health System, and f) Education for STEAM. The University Research and Development Service Office added another category which is the g) Social Science. Every year there is a priority category from the said categories, if the presented research in every colloquium falls to that priority category and gets accepted by the panel members, the URDS will monitor the granting of research proposals and the results of research grants will be displayed in the RPAD. The RPAD will suggest different grantors for different researches according to their research category.

Table 3
The Manual Computation for Expected T-Index of ECE Faculty for the Year 2017

ID No.	A	B	C	D	E	F	G
09	1	0.3	0.2	0	0	-	0.3
10	0	0	0	0	0	-	0.1
11	0.5	0.5	0.2	0	0	-	0.3
12	0	0	0	0	0	-	0.1
13	0.5	0	0	0	0	-	0.3
14	0.5	0	0.2	0	0	-	0.1
15	0.5	0	0	0	0	-	0.1
03	1	0	0	0	0	-	0.1
04	0.5	0	0	0	0	-	0.1
05	0.5	0	0	0	0	-	0.3
06	0	0	0	0	0	-	0.1
16	0	0	0	0	0	-	0.1
17	0.5	0	0	0	0	-	0.3
18	1.5	0.5	0.3	0	0	-	0.3
19	0.5	0.3	0.2	0	0	-	0.3
02	2	0	0.4	0	0	-	0.3

Table 4 shows the expected and predicted T-index of the year 2017. The highest educational attainment is considered through all the years. The parameters considered in choosing

faculties to be evaluated are (1) had a Google Scholar profile, (2) TUP faculty, and (3) active in research. The expected T-index value is computed using Equation 3. The accuracy of the T-index or the Faculty Valuation is 100%. The accuracy is computed using Eq.2.

$$Accuracy = \frac{Expected\ Value - Predicted\ Value}{Expected\ Value} x100\% \quad (2)$$

TABLE 4
MANUAL AND SYSTEM VALUATION OF ECE FACULTY YEAR 2017

Researcher ID No.	Expected T-index	Predicted T-index
READS-0000009	1.8	1.8
READS-0000010	0.1	0.1
READS-0000011	1.5	1.5
READS-0000012	0.1	0.1
READS-0000013	0.8	0.8
READS-0000014	0.8	0.8
READS-0000015	0.6	0.6
READS-0000003	1.1	1.1
READS-0000004	0.6	0.6
READS-0000005	0.8	0.8
READS-0000006	0.1	0.1
READS-0000016	0.1	0.1
READS-0000017	0.8	0.8
READS-0000018	2.6	2.6
READS-0000019	1.3	1.3
READS-0000002	2.7	2.7

C. Analysis and Result of the College Valuation

The manual computation of T-Index are done using Equation 2 and is reflected in Table 5. There are few researchers in the University that is why the population is very few. However, the total researches are high in numbers. Thus, the mean T-index is comparatively same with other colleges.

TABLE 5
THE MANUAL COMPUTATION FOR COLLEGE T-INDEX OF THE YEAR 2016 AND 2017

2016 College Valuation			
	Population	**Total Researches**	**Mean T-index**
CLA	2	4	1.3
COE	9	11	0.9888888889
CIE	6	6	1.033333333
COS	3	3	0.8666666667
CIT	4	4	0.85
CAFA	0	-	-
2017 College Valuation			
	Population	**Total Researches**	**Mean T-index**
COE	16	19	1.11875
CLA	6	4	0.7666666667
CAFA	1	1	0.3
COS	4	1	0.625
CIE	6	0	0.6166666667
CIT	4	0	0.5

The college valuation to be analyzed is computed based on Equation 2. As the academic year continues, yearly college T-index changes as shown in Table 6. This index will be the keystone for ranking colleges for its annual research performance. The researcher population is few because the website only considers faculties who have data for that year.

TABLE 6
THE COMPUTATION AND PREDICTED COLLEGE VALUATION YEAR 2016 AND 2017

2016 College Valuation		
	Expected	**Predicted**
CLA	1.442857143	1.448
COE	1.381746032	1.433
CIE	1.283333333	1.291
COS	0.9380952381	1.007
CIT	0.9928571429	0.998
CAFA	-	-
2017 College Valuation		
	Expected	**Predicted**
COE	1.87875	1.879
CLA	0.926666666	0.927
CAFA	0.34	0.34
COS	0.665	0.665
CIE	0.6166666667	0.617
CIT	0.5	0.5

The accuracy of the score results between manual computed and system computed is 98.74% with minor discrepancies on some colleges' scores. The errors are due to the system's computation. It only recognizes values up to three decimal places and rounds it up to the nearest value.

D. Analysis and Result of the Project Grant Valuation

Logistic Regression is used to distinguish the relationship of categorical dependent variables to one or more independent variables by finding probabilities using logistic function [10]. This machine learning uses either softmax function or sigmoid function. For this research categorization, the system used a softmax function. The difference between these functions is that softmax is used for multi classification while the latter is used for binary classification [11] [12]. Multinomial Logistic Regression works by having a prepared data with features extracted in numerical form. If the prepared data are not numerical, use proper categorical data analysis to convert the data into numerical form. Then, a linear model of the data is formed. This linear model includes weights for each parameter to be considered. The inputs can be processed by the linear model and will produce an output called logits. By applying the softmax function, the system can now determine the probability of its category. The higher the probability, the higher it might fall to that category. Using cross-entropy, the system can determine the similarity distance between the probabilities to be written into One-Hot-Encoding [13].

Using Logistic Regression, the model has a 100% probability of identifying grants that will be rejected based on these five parameters: (1) duration, (2) budget allocated, (3) score, (4) leader's t-index (5) and members' mean t-index. However, there is a 40% probability of identifying grants that have been declined in the test set. The model also has a good classification rate of 82% as shown in Table 7.

Table 7
Performance Measurement

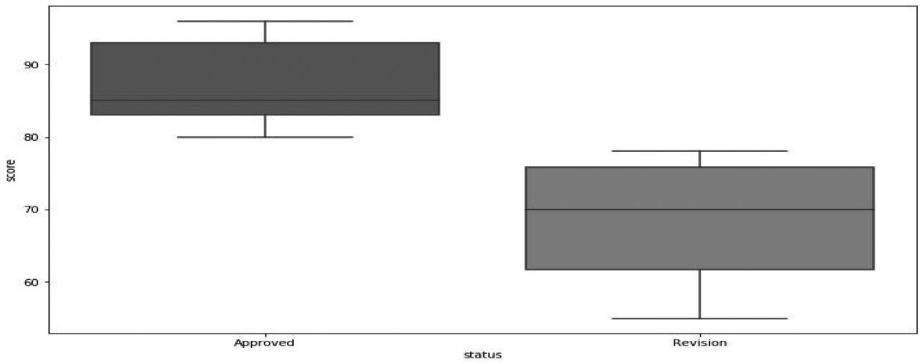
	Precision	Recall	F1-Score	Support
Approved	0.80	1.00	0.89	12
Revision	1.00	0.40	0.57	5
Micro avg	0.82	0.82	0.82	17
Macro avg	0.90	0.70	0.73	17
Weighted avg	0.86	0.82	0.80	17

Table 8 shows the accuracy of classifying grants between Approved and Revised with 82.35% precision of identifying Revised Grants and low recall of 40% of Revised grants in trained dataset. The total number of project grants involved in the analysis is 34 from the data collected in the 2019 research colloquium held in the deployed university.

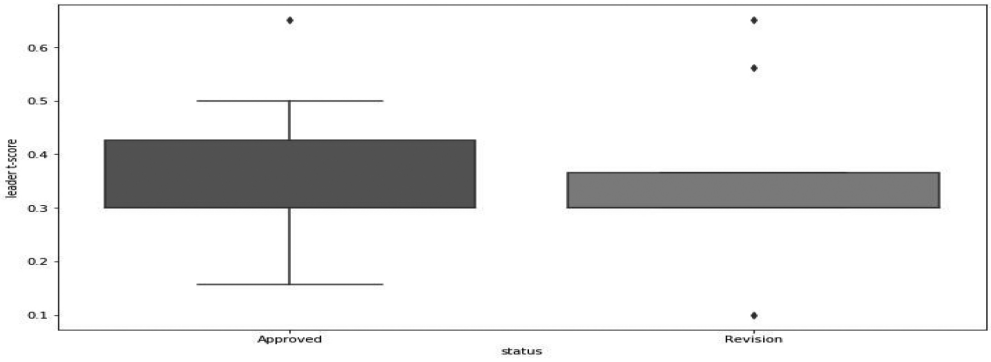
Table 8
Classification report

Accuracy	0.823
Precision	1.000
Recall	0.400

The system inferred that the higher the score and proponents' t-index, the more likely the research would be approved as shown in Figure 7. However, the lower the budget allocated in the grant and the duration of the project, the higher the probability the grants would be then approved.



(A)



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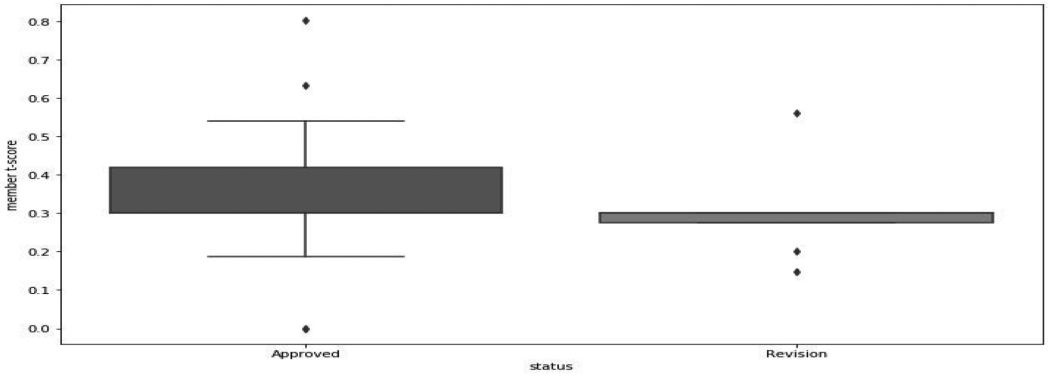

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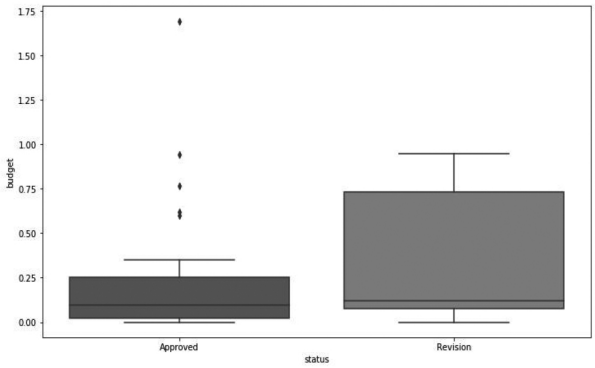

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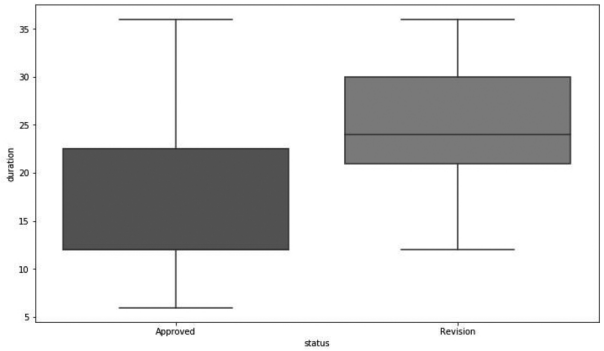

(E)

Fig. 7. Mean Parameter of Grants in (A) Score, (B) Leader's T-Index, (C) Member's T-Index, (D) Budget Allocation and (E) Duration of the Project

V. Conclusion

The study helped in keeping the data of the faculty members in the University using the developed database and in recognizing the researcher's ability and status of their research activities. The actualized valuations helped in creating specialist positioning, fulfilling University's desire and for proceeding with the consistently extending difficulties in measuring the capabilities of the faculty members based on their output. Creators accepted that this valuation encourages the analyst to be progressively forceful and improve their standing with regards to look into and will decidedly help Universities with raising their quality models. The similar assessments for all schools to screen their headway on the investigation front should be feasible for future work. In addition, inspect profoundly the key variables, inherently and extraneously, that persuade personnel specialists to perform well.

VI. References

[1] P. Balakumar, "The critical steps for successful research: The research proposal and scientific writing," *Journal of Pharmacology and Pharmacotherapeutics,* pp. 130-138, 2013.

[2] J. Geoffrey, "Journal Quality: A Google Scholar analysis," *Australian Marketing Journal,* no. 17, pp. 150-153, 2009.

[3] E. Tecson-Mendoza, "Scientific and Academic Journals in the Philippines: Status and Challenges," *Science Editing,* vol. II, no. 2, pp. 73-78, 2015.

[4] Y.He, "A Study on Quantitative Model of Performance Evaluation for Univeristy Researcher," in *2010 International Conference on Machine Vision and Human-machine Interface*, 2010.

[5] Q. Zhang, "A New Approach to Faculty Evaluation with Uncertain Information," in *2008 International Symposiums on Information Processing*, 2008.

[6] T. Rikakis, "Innovative Faculty Evaluation Criteria for Incentivizing High-impact Interdisciplinary Collaboration," in *39th ASEE/IEEE Frontiers in Education Conference*, 2009.

[7] K. Dennis, "Linking Academic Quality to Online Faculty Development and Evaluation," in *14th International Conference on Interactive Collaborative Learning (ICL2011)*, 2011.

[8] P. Shah, "Faculty Performance Evaluation Based on Prediction in Distributed Data Mining," in *2015 IEEE International Conference on Engineering and Technology (ICETECH)*, 2015.