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# Application of Data Envelopment Analysis in Assessing the Efficiency of Outstanding Student Organizations in a State University in the Philippines

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## Abstract

*Recognizing an organization's commitment and achievements is essential for fostering motivation and continuous improvement. At a state university in the Philippines, i.e., University of Science and Technology of Southern Philippines – Cagayan de Oro (USTP CDO), the USTP Kahamili Awards have been introduced to recognize outstanding student organizations operating within a diverse and dynamic university environment. However, the traditional manual rating system used in the evaluation process is prone to potential bias and inefficiency. To address these issues, this study implemented Data Envelopment Analysis (DEA) as an objective technique for assessing the efficiency of student organizations. Variable Returns to Scale (VRS) and Constant Returns to Scale (CRS) models were employed to evaluate the performance of various organizations. Academic Year 2021–2022 results revealed that three academic and three non-academic organizations were relatively efficient and subsequently recognized in the Kahamili Awards. Benchmarking analysis indicated that less efficient organizations require further evaluation and support to enhance their performance. Furthermore, the analysis demonstrated that the CRS model provided a better fit for the data than the VRS model, indicating that the efficiency of student organizations is more accurately captured under the assumption of constant returns. The findings demonstrate that DEA provides a fair and systematic approach to recognizing organizational excellence and identifying opportunities for continuous development among student organizations.*

***Keywords****:* data envelopment analysis, higher education institutions, organizational performance evaluation, student organization efficiency

## 1. Introduction

Colleges and universities are complex institutions operating in diverse, ever-changing environments shaped by shifting values, fluctuating economic conditions, and evolving political landscapes (Zhang and Cao, 2024). Despite these challenges, they have remained remarkably resilient, standing as one of the oldest and most enduring organizational forms in human history (Faulton, 2019). Initially established to educate the elite for leadership roles, their mission has broadened to become a key driver of economic and social mobility across all levels of society. These institutions serve as hubs of innovation, producing technologies that enhance human life, and as centers of learning that empower individuals with lifelong knowledge, civic responsibility, and personal growth (Chankseliani *et al.*, 2021). The organizational structure of educational institutions is broad and multifaceted, encompassing institutional efficiency, practical strategies for maximizing outcomes, clarification of roles and functions, alignment of academic programs, and effective planning and execution. A well-organized school promotes shared responsibility, purposeful collaboration, and strategic direction. Each institution functions through a defined internal structure that governs departmental roles, resource distribution, and leadership. Assessing organizational efficiency is vital for performance recognition and improvement. However, traditional evaluation methods often rely on subjective expert opinions, which are prone to bias due to varying interpretations. For example, the Kahamili Awards at the University of Science and Technology of Southern Philippines – Cagayan de Oro (USTP CDO) recognize outstanding student organizations. Yet, such recognitions are often based on evaluative systems that may not fully reflect objective performance metrics.

Evaluating the performance of student organizations at USTP CDO is therefore crucial to ensuring the effective delivery of student services. However, prevailing evaluation approaches, particularly scoring systems that overlook the differences between academic and non-academic organizations, are susceptible to bias. To address this limitation, Data Envelopment Analysis (DEA) presents a more objective alternative. It enables the assessment of decision-making units (DMUs) by measuring their relative efficiency with reduced bias. As such, this study employed the DEA model to evaluate the performance efficiency of student organizations at USTP, offering a more reliable basis for comparison and improvement.

DEA has been widely applied across various sectors in the Philippines. It has proven effective in evaluating service efficiency in the health sector. Lavado *et al.* (2010) assessed public health units across Philippine provinces and found that only a few were efficient. Similarly, Namoco and Pailagao (2017) used an output-oriented CCR model to evaluate selected private hospitals in Southern Philippines, revealing that 1 out of 10 was inefficient. Their study highlighted the DEA's value in identifying performance gaps and guiding improvements through benchmarking. In agriculture, Palacpac and Valiente (2023) utilized an input-oriented, variable-returns-to-scale DEA model to assess the efficiency of dairy buffalo farms in Nueva Ecija. Their study identified benchmarks and emphasized the role of extension services in improving farm efficiency. In the realm of governance, Lavado *et al.* (2014) applied DEA to estimate a good governance index for Philippine provinces, revealing insights into how local governments can set performance targets and enhance various governance indicators. In the area of research and development, Dobrzanski and Bobowski (2020), as well as Afzal and Lawrey (2014), evaluated R&D spending efficiency in ASEAN countries, identifying the Philippines as one of the most efficient in converting R&D inputs into outputs under both constant and variable returns to scale. Sirisunhirun and Vajrapatkul (2023) further employed DEA and the Malmquist Productivity Index to evaluate the productivity of human capital development in ASEAN-5 countries, noting significant improvements in the Philippines due to technological advancement.

In the Philippine education sector, DEA has also been instrumental. Madria *et al.* (2019) compared standard DEA and network DEA (NDEA) models in assessing university research efficiency, concluding that NDEA provides a more comprehensive evaluation by incorporating both quantity and quality of outputs. Tibay *et al.* (2019) used DEA to measure the performance efficiency of elementary and secondary schools under the Department of Education, identifying benchmark schools and employing K-Means clustering for targeted interventions. Similarly, Acodile-Viado and Namoco (2020) evaluated the efficiency of selected state universities and colleges (SUCs) in Southern Philippines using input-oriented Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) models. Their study found that under the CRS model, only 10 out of 26 SUCs were efficient, while 13 were efficient under the VRS model, demonstrating DEA's utility in diagnosing performance gaps and providing benchmarks for improvement.

Globally, DEA has also been widely adopted in the educational context. In the United States, DEA has been extensively used to evaluate the efficiency of universities, including Master of Business (MBA) programs and technology transfer initiatives (Fu and Huang, 2009; Kim *et al.*, 2008). In the United Kingdom, the method has been employed to assess the efficiency of economics departments and overall university performance (Fu and Huang, 2009). Similarly, studies in Australia have applied DEA to examine the efficiency of entire universities and individual departments (Fu and Huang, 2009). In Turkey, Dogan (2023) utilized a two-stage Network DEA model to assess research universities, finding that only a few institutions were efficient. Comparative studies in Italy and Poland have shown considerable variability in efficiency scores, influenced by internal factors such as revenue structures and faculty composition (Agasisti and Wolszczak-Derlacz, 2015). In Nigeria, DEA has been used to identify high-performing federal universities that serve as performance benchmarks (Inua and Maduabum, 2014).

Despite the extensive global and local use of DEA in assessing organizational and institutional efficiency, no prior study has focused on applying DEA to evaluate the performance of student organizations at a higher education institution, especially in the Philippines. To fill this research gap, the present study aimed to identify the decision-making units (DMUs) and their relevant performance indicators, develop a mathematical model to evaluate student organization efficiency, compute and compare the relative efficiency scores of student organizations for the academic year (AY) 2021–2022, and validate DEA results against the actual outcomes of the Kahamili Awards at USTP CDO.

## 2. Methodology

### *2.1 Identification of the DMUs and their Performance Indicators*

This study categorized the DMUs selected into academic and non-academic student organizations at USTP CDO. Eight academic organizations and eight non-academic organizations were considered DMUs for AY 2021-2022, as shown in Table 1. The distinction between academic and non-academic organizations in a university lies mainly in their purpose, affiliation, and focus. Academic colleges or departments sponsor academic organizations and consist of students related to their field of study or specialization. Their goals

include deepening knowledge in a specific discipline, preparing for future careers, networking with faculty and peers, and enhancing field-specific skills. On the other hand, non-academic organizations are not directly affiliated with academic departments and are open to all students regardless of their academic major. They focus on extracurricular, social, cultural, leadership, and personal interest activities that foster community and holistic growth. Common types include cultural clubs, residence councils, faith-based groups, hobby clubs, and support groups.

The input and output parameters identified and considered in this study were provided by the USTP Office of Student Affairs (USTP OSA), with the following input variables: the total proposed or planned events/activities to be held by each student organization (1), and the total budget allocated for each student organization (2). On the other hand, the output variables identified were the following: the actual accomplishment report as declared in the Annual Work and Financial Plan (AWFP) (1), the organization's contribution to the university's mission/vision rating score (2), and the impact of the organization's contribution rating score (3).

In defining the inputs used in the model, the number of events held refers to the total number of activities planned by a student organization within a given academic year. The total budget available denotes the amount of financial resources allocated to each student organization for implementing activities within the university. For the outputs, the AWFP actual accomplishment refers to the actual accomplishments carried out by the organization based on its AWFP. Additionally, the organization's contribution to the university's mission and vision reflects the extent to which its activities align with and support its core goals. A panel evaluates this criterion and contributes 20% to the overall assessment. The impact of the organization's contribution indicates how significantly the organization's efforts influence the university community. Like the previous criterion, it is assessed by a panel and accounts for 30% of the total score. The selection of input and output indicators for the DEA model was based on the completeness, availability, and credibility of data.

Table 1. USTP Kahamili Awards Academic Year 2021–2022

| Org. no | DMU no. | Type of organization | Input | | | Output | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TAH | TBA | AAA | OCU (P1) | OCU (P2) | OCU (P3) | IOC (P1) | IOC (P2) | IOC (P3) |
| 1 | 1 | Non-academic | 11 | 0 | 28 | 15 | 17 | 14 | 15 | 28 | 26 |
| 2 | 2 | Non-academic | 17 | 16506.32 | 50 | 20 | 20 | 15 | 20 | 29 | 25 |
| 3 | 3 | Non-academic | 19 | 0 | 50 | 17 | 19 | 15 | 25 | 28 | 26 |
| 4 | 4 | Non-academic | 21 | 39080.89 | 26 | 18 | 19 | 13 | 25 | 29 | 23 |
| 5 | 5 | Non-academic | 1 | 10500 | 18 | 18 | 17 | 14 | 24 | 27 | 25 |
| 6 | 6 | Non-academic | 6 | 23702.79 | 34 | 19 | 19 | 17 | 28 | 29 | 28 |
| 7 | 7 | Academic | 2 | 70443.72 | 18 | 16 | 19 | 16 | 25 | 28 | 27 |
| 8 | 8 | Academic | 10 | 9449.53 | 35 | 13 | 19 | 15 | 22 | 29 | 24 |
| 9 | 9 | Academic | 15 | 20043.63 | 25 | 13 | 18 | 14 | 20 | 28 | 24 |
| 10 | 10 | Non-academic | 17 | 0 | 50 | 15 | 18 | 16 | 23 | 28 | 26 |
| 11 | 11 | Academic | 30 | 95525.05 | 17 | 26 | 17 | 17 | 23 | 27 | 28 |
| 12 | 12 | Academic | 51 | 106698.09 | 38 | 28 | 19 | 14 | 28 | 26 | 24 |
| 13 | 13 | Academic | 35 | 91810.85 | 21 | 15 | 19 | 13 | 22 | 27 | 20 |
| 14 | 14 | Academic | 30 | 234534.1 | 22 | 15 | 19 | 15 | 24 | 28 | 25 |
| 15 | 15 | Academic | 40 | 98849.06 | 29 | 15 | 17 | 14 | 23 | 29 | 25 |
| 16 | 16 | Non-academic | 21 | 686447.6 | 50 | 20 | 16 | 25 | 30 | 26 | 26 |

DMU – Decision-Making Unit; TAH – Total Activities Held; TBA – Total Budget Allocated (in Php); AAA – Annual Work and Financial Plan (AWFP) Actual Accomplishment; OCU – Organizations' Contribution to the University's Mission/Vision; and IOC – Impact of Organizations' Contribution

Moreover, in considering the total number of activities to be implemented and the total estimated allocated budget as inputs, the DEA model assesses how efficiently the student organizations utilize and manage these resources to produce desirable outputs, such as conducting successful events and engaging members. The estimated total budget represents the financial resources available to the organization, which are essential for planning and executing activities. Similarly, the total proposed activities indicate the intended effort, time, and resources dedicated by the organization to achieve outcomes. These inputs capture the student organizations' nature of operations.

Meanwhile, the actual accomplishments, as reported in the AWFP, are considered output variables because they represent the realized results or achievements of the student organizations. These outputs reflect the effective delivery of services, completed activities, and achieved goals, showing the tangible outcomes generated from the invested resources and efforts. In DEA, outputs measure what organizations have produced or accomplished, making actual accomplishments an appropriate choice as they demonstrate the value created from inputs such as budget and planned activities. This aligns with the DEA's fundamental principle of comparing inputs against outputs produced to evaluate performance and efficiency.

### *2.2 Development of a Mathematical Model to Evaluate the Efficiency of Student Organizations*

The input-oriented DEA model was used in this study to evaluate the efficiency of the student organization. An input-oriented model instructs DEA to reduce the inputs as much as possible without dropping the level of outputs (inputs are controllable). The DMU being evaluated is deemed to produce a given amount of maximum outputs with the smallest possible amount of inputs. In this study, the DEA input-oriented Constant Returns to Scale (CRS) model and the input-oriented Variable Returns to Scale (VRS) model were utilized to achieve the efficiency results of USTP Cagayan de Oro student organizations. Both models were employed in the study to determine the efficiency of organizations because it was uncertain whether organizations performed at optimal operation.

The CRS model was applied because it assumed that the input and output parameters used by the student organizations conformed to the CRS specification. CRS assumes that outputs change in the same proportion as changes in inputs. However, this assumption may not always hold for student

organizations. Therefore, the VRS DEA model was also employed to measure their efficiency. The VRS model assumes that the amount of outputs accomplished by an organization may increase by more or less than the proportional input increase.

Both input-oriented DEA models were utilized to compare all resources used (input parameters) and services provided (output parameters) by each organization, considering data availability at the USTP OSA and measurement quality. In using these models, the evaluation compared the resources consumed (input variables such as proposed/planned activities and budget allocation) with the services or achievements provided (output variables such as actual accomplishments reported on the AWFP, contributions to the university's vision and mission, and the overall impact of the organization's efforts).

In an input-oriented DEA model, the main goal is to determine how much an organization can reduce its inputs while still producing the same output. Although this means minimizing inputs conceptually, the mathematical formulation of the objective function may be written as a maximization problem of an efficiency score related to inputs. This is the reason why maximizing an input efficiency measure (which increases as inputs decrease) is equivalent to minimizing the inputs themselves, as shown in Equation 1. Thus, even if the objective function appears as a maximization problem, it still fundamentally represents reducing inputs to improve efficiency.

The resulting data envelopment analysis model of each student organization for AY 2021–2022 is illustrated below (Equation 1).

$$\text{Maximize } Z = u_{p,AAA}x_1 + u_{p,OCU(P1)}x_2 + u_{p,OCU(P2)}x_3 + u_{p,OCU(P3)}x_4 + u_{p,IOC(P1)}x_5 + u_{p,IOC(P2)}x_6 + u_{p,IOC(P3)}x_7$$

Subject to Restrictions:

$$w_{p,TAH}y_1 + w_{p,TBA}y_2 = 1$$

$$u_{1,AAA}x_1 + \sum_{i=1}^{3}\sum_{j=2}^{4} u_{1,OCU(Pi)}x_j + \sum_{i=1}^{3}\sum_{j=5}^{7} u_{1,IOC(Pi)}x_j \le w_{1,TAH}y_1 + w_{1,TBA}y_2$$

$$u_{2,\,AAA}x_1 + \sum_{i=1}^{3}\sum_{j=2}^{4} u_{2,OCU(Pi)}x_j + \sum_{i=1}^{3}\sum_{j=5}^{7} u_{2,IOC(Pi)}x_j \le w_{2,TAH}y_1 + w_{2,TBA}y_2$$

$$u_{3,\,AAA}x_1 + \sum_{i=1}^{3}\sum_{j=2}^{4} u_{3,OCU(Pi)}x_j + \sum_{i=1}^{3}\sum_{j=5}^{7} u_{3,IOC(Pi)}x_j \le w_{3,TAH}y_1 + w_{3,TBA}y_2$$

$$\vdots$$

$$u_{p,\,AAA}x_1 + \sum_{i=1}^{3}\sum_{j=2}^{4} u_{p,OCU(Pi)}x_j + \sum_{i=1}^{3}\sum_{j=5}^{7} u_{p,IOC(Pi)}x_j \le w_{p,TAH}y_1 + w_{p,TBA}y_2$$

$$x_1, x_2, x_3, x_4, x_5, x_6, x_7, y_1, y_2 \ge 0 \qquad (1)$$

*where:*

*TAH = Total Activities Held*
*TBA = Total Budget Allocated*
*AAA = Annual Work and Financial Plan (AWFP) Actual Accomplishment*
*OCU = Organizations' Contribution to the University's Mission/Vision*
*IOC = Impact of Organizations' Contribution*

### *2.3 Computation of the Scale Efficiency of USTP Student Organizations*

The determination of the efficient student organizations was based on the value of the efficiency scores. A particular decision-making unit is considered efficient if the corresponding efficiency ratio is equal to 1, as shown in Equation 2. Otherwise, the said decision-making unit is less efficient. In connection with this study, if the efficiency ratio of a student organization is equal to 1, then the student organization is efficient. That is, it is more efficient in converting its resources into outputs than other student organizations.

$$SE(x_i, y_i) = \frac{E(x^0, y^0; CRS)}{E(x^0, y^0; VRS)} \qquad (2)$$

### *2.4 Comparison of Computed DEA Results to Kahamili Actual Results*

The results obtained from the VRS and CRS DEA models were compared to the actual raw results to determine whether they align with the outcomes achieved without the use of the optimization model. This comparison involves

assessing whether the awards received by each DMU correspond to their computed efficiency scores. Cross-validation was also employed to identify discrepancies or errors between the actual and DEA-derived results, providing insights into the accuracy and reliability of the model.

## 3. Results and Discussion

### *3.1 Efficient Student Organizations in Academic Year 2021–2022*

Table 2 presents the relative efficiencies of student organizations in the USTP Kahamili Awards for AY 2021–2022 across academic and non-academic categories. Two out of eight organizations were efficient in the VRS DEA model for academic student organizations. In contrast, the CRS DEA model identified five out of eight academic organizations as efficient. The scale efficiency, which reflects the gap between CRS and VRS scores, indicates how effectively an organization operates at its optimal scale. Notably, Organizations 7, 8, and 10 emerged as the most efficient across both DEA models.

Table 2. The relative and scale efficiencies of student organizations in the USTP Kahamili Awards for AY 2021–2022 in the VRS and CRS DEA model in both academic and non-academic

| Category | DMU (Org no.) | Objective function value (VRS Model) | Objective function value (CRS Model) |
|---|---|---|---|
| Academic | 7 | 1.00000 | 1.00000 |
| | 8 | 1.00000 | 1.00000 |
| | 9 | 0.63323 | 0.63755 |
| | 11 | 0.49875 | 1.00000 |
| | 12 | 0.36019 | 1.00000 |
| | 13 | 0.26324 | 0.34191 |
| | 14 | 0.18915 | 0.21061 |
| | 15 | 0.23462 | 1.00000 |
| Non-academic | 1 | 1.00000 | 1.00000 |
| | 2 | 0.67868 | 1.00000 |
| | 3 | 0.96822 | 1.00000 |
| | 4 | 0.22510 | 0.53745 |
| | 5 | 1.00000 | 1.00000 |
| | 6 | 0.65839 | 1.00000 |
| | 10 | 1.00000 | 1.00000 |
| | 16 | 0.13228 | 1.00000 |

For non-academic student organizations, three out of eight were efficient under the VRS model, while seven out of eight were deemed efficient under the CRS model. Scale efficiency results showed that Organizations 1, 5, and 10 were the most efficient in both VRS and CRS models. These findings suggest that these student organizations have effectively utilized their inputs, namely the number of implemented projects and the available budget, to achieve desirable outputs.

According to Ponce *et al.* (2024), efficient budgeting and effective event management are crucial for student organizations, as the execution of activities impacts not only the organization itself but also the broader university community. In line with this, the present study underscores the importance of proper budgeting and strategic project implementation among student organizations, as these factors contribute to student welfare and can influence the overall reputation of both the organization and the university.

### *3.2 Scale Efficiency of Organizations in Academic Year 2021–2022*

The scale efficiency scores, presented in Table 3, revealed varying levels of operational efficiency among both academic and non-academic student organizations. Several academic organizations, such as DMUs 7 and 8, operated at an optimal scale with a perfect efficiency score of 1, indicating that they utilized their resources effectively to maximize performance. Similarly, DMUs 9 and 14 exhibited high efficiency, suggesting near-optimal scale operations. However, other academic units like DMUs 11, 12, and 15 showed notably low scale efficiencies, with scores below 0.5, which implies that these organizations may be operating at an inefficient scale, either too small or too large to achieve maximum productivity. DMU 15, in particular, demonstrated a critical need for scale adjustment as it had the lowest efficiency score among academic units. In the non-academic category, DMUs 1, 5, and 10 were also operating at an optimal scale, while DMUs 2 and 3 had moderate efficiencies, indicating some room for improvement. On the other hand, a few non-academic organizations, especially DMU 16, with a very low scale efficiency of 0.13228, reflected considerable inefficiencies in their scale of operation. The less efficient DMUs need to be evaluated so that efficiency can be improved. Overall, these findings highlight that while several student organizations function efficiently, many others would benefit from scale adjustments or strategic resource reallocation to enhance their productivity and overall effectiveness within the institution.

Table 3. Scale efficiency of student organizations for AY 2021–2022

| Category | DMU (Org no.) | Scale efficiency |
|---|---|---|
| Academic | 7 | 1.00000 |
| | 8 | 1.00000 |
| | 9 | 0.99322 |
| | 11 | 0.49875 |
| | 12 | 0.36019 |
| | 13 | 0.76992 |
| | 14 | 0.89810 |
| | 15 | 0.23462 |
| Non-academic | 1 | 1.00000 |
| | 2 | 0.67868 |
| | 3 | 0.96822 |
| | 4 | 0.41883 |
| | 5 | 1.00000 |
| | 6 | 0.65839 |
| | 10 | 1.00000 |
| | 16 | 0.13228 |
| | 16 | 0.13228 |

### *3.3 Comparison of the DEA and Actual Results*

Comparing the computed results to the actual results of the USTP Kahamili Awards, as shown in Table 4, summarizes the actual results during AY 2021–2022 and the obtained results via DEA. It showed that the DEA CRS model more accurately predicted the actual results than the DEA VRS model, since most of the DMUs that were gold awardees were marked as efficient. In the DEA VRS model, however, some gold awardees were marked as inefficient, particularly DMUs 12 and 15 in the academic category and DMUs 2, 3, 6, and 16 in the non-academic category. This implies that the DEA CRS model best fits the actual results of this AY.

Overall, DEA offered practical implications for university management by providing a quantitative, data-driven method to evaluate the relative efficiency of student organizations. DEA helped identify which units operated efficiently and which did not, offering insights into how resources were utilized. Inefficient units can use DEA results to pinpoint areas requiring improvement, such as reducing excessive resource utilization or enhancing performance outputs. It also showed that the CRS data envelopment analysis model best fits the results of the USTP Kahamili Awards. It is assumed that changes in input levels led to equal proportional changes in output levels.

Table 4. Comparison of the actual results of academic and non-academic student organizations in USTP Kahamili Awards AY 2021–2022 and results obtained via DEA VRS and DEA CRS model

| Category | DMU (Org no.) | Actual Kahamili Award | Efficient/not (VRS model) | Efficient/not (CRS model) |
|---|---|---|---|---|
| Academic | 7 | Silver | Efficient | Efficient |
| | 8 | Silver | Efficient | Efficient |
| | 9 | Silver | Not | Not |
| | 11 | Silver | Not | Efficient |
| | 12 | Gold | Not | Efficient |
| | 13 | Silver | Not | Not |
| | 14 | Silver | Not | Not |
| | 15 | Gold | Not | Efficient |
| Non-academic | 1 | Silver | Efficient | Efficient |
| | 2 | Gold | Not | Efficient |
| | 3 | Gold | Not | Efficient |
| | 4 | Silver | Not | Not |
| | 5 | Silver | Efficient | Efficient |
| | 6 | Gold | Not | Efficient |
| | 10 | Gold | Efficient | Efficient |
| | 16 | Gold | Not | Efficient |

However, some DMUs were misclassified by the said model. According to Yazdi *et al.* (2023), two factors can affect the results of the DEA model. First is the existence of outliers in the data, which can distort efficiency scores. Moreover, data envelopment analysis has a limited discriminatory power. That is, when most of the decision-making units. Thus, it is recommended to integrate this model into other classification models, such as the well-known principal component analysis, which is a multivariate technique that aims to reduce the dimension of the variables through the use of the vector projections of all variables in the principal components considered. Aside from that, T-SNE and SBM models can also be considered by future studies since these models can handle nonlinearities as well as outliers. Similarly, super efficiencies can also be considered to determine which DMUs are the most efficient throughout the academic years.

## 4. Conclusion and Recommendation

This study showed that DEA efficiently compared DMUs with less bias and human error. The results indicated that Organizations 7, 8, and 10 were the most efficient for all academic student organizations, and Organizations 1, 5, and 10 were the most efficient for all non-academic student organizations in the USTP Kahamili Awards AY 2021–2022. This implies that these organizations have efficiently utilized their inputs in terms of the number of activities held and the total budget available. The study also revealed that inefficient student organizations lacked budget availability, which could significantly affect the number of activities held. In addition, it showed that decreasing the objective-function value coefficients of the linear programming models of efficient student organizations did not change the objective-function value. Lastly, the CRS DEA model best fitted the actual raw results of the USTP Kahamili Awards in both academic years compared with the VRS DEA model.

Based on the findings of this study, several recommendations are proposed to enhance future research and analysis. It is suggested that additional input variables in the DEA model, such as total expenditure and current student-satisfaction ratings of each student organization, be considered while also incorporating other relevant output variables to achieve a more comprehensive evaluation. Because peer-restricted cross-efficiency evaluation cannot fully project all inputs and outputs of inefficient DMUs, alternative benchmarking methods should also be explored. Furthermore, assessing the super-efficiencies of student organizations is recommended to better understand their overall performance in each academic year and to enable ranking of efficient units, which can help break ties and identify outstanding organizations. Adopting a longer time frame in future analyses may yield more reliable and insightful results. Integrating DEA with the Analytical Hierarchy Process (AHP) is advised to help determine the prioritization of each input and output variable. Bootstrapping should be conducted to evaluate potential bias in the model, with comparisons made across different numbers of iterations to analyze bias-corrected efficiency values. Additional validation techniques, including the use of methods such as K-means clustering, Random-Forest regression, and Support-Vector Machine analysis, may also be explored to further enhance result validity. Lastly, exploring other variations of DEA models could further extend and deepen the analysis.

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