Plagiarism Checker X Originality Report

Similarity Found: 12%

Date: Jumat, April 06, 2018
Statistics: 349 words Plagiarized / 2808 Total words
Remarks: Low Plagiarism Detected - Your Document needs Optional Improvement.

A Research Framework for Data Envelopment Analysis with Upper Bound on Output to Measure Efficiency Performance of Higher Learning Institution in Aceh Province D Abdullah#*, Tulus*, S Suwilo*, S Efendi*, M Zarlis*, H Mawengkang* # Department of Informatics, Universitas Malikussaleh, Jalan Cot Tengku Nie Reuleut Muara Batu, Aceh Utara, 24355, Indonesia E-mail: dahlan@unimal.ac.id *Department of Computer Science, Universitas Sumatera Utara, Jalan Universitas No.

9 A, Medan, 20155, Indonesia E-mail:tulus_jp@yahoo.com Ab s tr a ct — The higher education system in Indonesia can be considered not only as an important source of developing knowledge in the country, but also could create positive living conditions for the country. Therefore it is not surprising that enrollments in higher education continue to expand.

Data envelopment analysis (DEA) is a method to evaluate the technical efficiency of production units which have multiple input and output. The higher learning institution considered in this paper is Min Aceh province of Indonesia. This research framework will using DEA with bounded output. Accordingly, we present some important differences in efficiency of those higher education institute.

Finally we discuss the effort should be done by these departments in order to become efficient. Keywords — Data Envelopment Analysis, Efficiency, Higher Education, Performance Measurement, Upper Bound I. INTRODUCTION Research on benchmarking is now evolving as a follow-up to the process of improvement, quality assurance, evaluation and performance improvement [1].

The benchmarking process is basically a process of measuring efficiency that calculates

the ratio between input and output. However, the problem is that the ratio will be able to calculate the validity if it involves 1 (one) input and 1 (one) output. [2] proposes a method that can measure efficiency by using multiple outputs and inputs called relative efficiency, by calculating the ratio of the weight of the output sum and the weight of the input sum.

[3] developed the [2] idea to develop a method for evaluating the relative efficiency of the Decision Making Unit (DMU) set. The model for Measurement of DEA efficiency has been proposed by [3], known as DEA Charnes, Copper, and Rhodes (DEA CCR) has been used by a number of researchers for the measurement of relative efficiency by using DEA. [4] uses the DEA CCR Model for efficiency measurement in the medical sector.

[5] have used DEA CCR to measure the relative efficiency of capital and resource placement. DEA has become one of the most appropriate methods for comparing the various Decision Making Units (DMU) associated with public services such as universities [6]. There is currently no performance measurement process undertaken either by the government for the higher education level in Aceh Province.

Higher Education has a very big role in improving the quality of human life. In Indonesia, universities as institutions of higher education have a great responsibility to improve the quality of life of the community, to develop the welfare of the state and to increase scientific knowledge. For this reason, the Government of Indonesia has sought to raise funds to support the education process.

This is common in the higher education sector in Indonesia to gain some financial support from public funding, especially from the cost of student education. The same situation also occurred in the existing universities in the province of Aceh, Indonesia. Measuring the efficiency of college performance is very important to do, but it is difficult to do considering the characteristics of each different college especially if the college is viewed as a non profit organization with multiple output generated from multiple inputs.

A study by [7] has two main outputs that can be used to measure college performance: the number of graduates and the number of publications. On the other hand, research conducted by [8] that the main inputs of measuring the efficiency efficiency of college performance are the number of teaching staff and the number of students.

Similar research has previously been conducted by [9] using DEA method to measure relative efficiency by conducting research on 109 colleges in China in 2003 and 2004. In their research, Impact measurements and research productivity were made as output

Variables and as input variables used the number of teaching staff, the number of graduates, capital, and resources. In conventional Data Envelopment Analysis, the data in general is assumed to be non-negative with no specific limitations.

However, some cases require some restrictions on the data [10]. [11] has assumed that each DMU has a range of values for each input and output measurement. The rationale is that each DMU has limits for input and output. In [11] uses lower bounds input and upper bounds output to define the limits of efficiency measurement. [12] suggests a DEA- oriented method of studying the relationship between input and output.

[13] has examined that an unexpected number of outputs may arise in the form of deviation of the resulting output, based on the existing input parameters, if there is no limit to the output. This is seen in the study by [14] conducted a study on the efficiency of school performance in Greece using the lower bound on the input and upper bound on the output, where an inefficient Decision Making Unit (DMU) can occur.

The main constraint when establishing bounded on input and output based on the results of research conducted by [14] is the presence of missing value on input and output and [14] corrected the missing value by using Fuzzy DEA. Research conducted by experts so far there has been no research that discusses the upper bound output to fixed input.

Where, for reasons of the quality of college performance efficiency measurement, the input bound is assumed to be fixed and the output will increase proportionally along with the utilization of the existing input. Fixed input is caused by the addition of resources at the university especially for the input of the teaching staff and the number of students has a quota set by the Ministry of Research, Technology and Higher Education (Kemenristek Dikti) which can not be added, but who want to increase is an increase in output (Upper bound on output).

The Data Envelopment Analysis (DEA) with Upper Bound on Output is aimed at measuring the efficiency of university performance in Aceh using two main inputs: Number of Lecturers and Number of Students as well as 2 (two) main outputs: Number of Research And Number of Graduates. This research is needed to describe the performance efficiency level of each university. II.

THE MATERIAL AND METHOD/ALGORITHM Research conducted by experts so far there has been no research that discusses the upper bound output to fixed input. Where, for the reason of the quality of college performance efficiency measurement, the input bound is assumed to be fixed and the output will increase proportionally along with the

increase of the explored input.

The EnvelopmentAnalysis (DEA) data with Upper Bound on Output is aimed at measuring the efficiency of the performance of universities in Aceh using two main inputs: Number of Teaching Staff and Number of Students as well as 2 (two) main outputs: Number of Research and Number of Graduates. A. Data Data source for benchmarking in this research is data of university in Aceh Province.

There are several variables observed for performance measurement, namely: Number of Lecturers, Number of Students, Number of Research, and Number of Graduates. B. Research Process The phase of the research process can be seen in Fig. 1. Fig. 1 Phases of the Research Process A. Fractional Programming with CCR Method Fractional Programming with CCR Method can be modeled by the following equation.

(1) Limit or constraint function: (2) Where: Efficiency of object s k = output of object s observed yis= the number of outputs i produced by object s xjs= number of inputs i used by object s ui= the output weight i produced by object s vj= the input weight i given by object s In the model, there are n number of DMUs with k number of outputs resulting from l number of inputs. yrj (>0) are the number of output of the jth DMU and (>0) are the number of input of the jth DMU.

and vs are the variable weights to be determined after solving the model. B. Linear Programming with CCR Method The model (1) is in the form of fractional programming, it would be computationally intractable particularly when the number of DMUs is large.

Therefore it is necessarily to convert the model (1) into a linear programming problem, as proposed by [2], which can be written as follows (output oriented). (3) Subject to III. RESEARCH FRAMEWORK [15] have proposed linear programming models to generate bounded intervals as can be seen in Equations 4 and 5. ???? ?? ???? ?? - ? ?? ???? ?? ???? ?? = 1 ?? ?? = ?? ???? , ?? ???? , (4) In Equation (4), it can be seen that the DMU is in an under evaluation state in the sense that the issued input is still greater than the maximum output produced.

This equation can be refined to produce an output bounder by using linear programming as can be seen in Eq. (5). ???? ?? ???? ?? ?? ?? = 1 = 0 , ?? = 1 , 2 , … . , ?? ?? ?? = 1 ?? ?? ?? * ? ?? ???? ?? ???? ?? ?? ?? = 1 - ? ?? ???? = ? , ? (5) e obtained by using equation (6). ???? = ? , ? (6) Where value of is essentially the result of a linear equation for the sum of the input values of each DMU.

For more details, suppose there are DMUs with inputs and outputs as can be seen in

Table 1. TABLE I LIST OF DMU WITH INPUT AND OUTPUT NO DMU INPUT OUTPUT NUMBER OF TEACHING STAFF NUMBER OF STUDENTS NUMBER OF RESEARCH NUMBER OF GRADUA TES 1 INFORMATION TECHNOLOGY 17 588 5 610 2 CIVIL ENGINEERING 26 747 5 533 3 ARCHITECTURA L ENGINEERING 15 396 5 195 4 INDUSTRIAL ENGINEERING 17 467 5 300 5 CHEMICAL ENGINEERING 25 348 5 252 6 MECHANICAL ENGINEERING 23 499 5 224 7 ELECTRICAL ENGINEERING 19 420 5 326 8 AGRIBUSINESS 17 689 5 273 9 AGRO- TECHNOLOGY 34 822 5 284 10 AQUACULTURE 10 501 5 204 11 COMMUNICATIO N SCIENCE 11 719 5 273 12 POLITICAL SCIENCE 11 262 5 183 13 SOCIOLOGY 13 487 5 204 14 ANTHROPOLOG Y 9 173 5 116 15 JURISPRUDENCE 50 1096 10 467 16 MEDICINE 30 278 4 257 17 MANAGEMENT 48 1265 5 1302 18 ECONOMIC DEVELOPMENT 11 853 5 290 19 ACCOUNTING 23 1127 5 417 To perform the Upper Bound process of output can be done using Equation (7).

Maximize 610 U1 + 5 U2 Subject to 17 V1 + 588 V2 = 1 (7) 610 U1 + 5 U2 - 17 V1 - 588 V2 <= 0 533 U1 + 5 U2 - 26 V1 - 747 V2 <= 0 195 U1 + 5 U2 - 15 v1 - 396 V2 <= 0 300 U1 + 5 U2 - 17 V1 - 467 V2 <= 0 252 U1 + 5 U2 - 25 V1 - 348 V2 <= 0 224 U1 + 5 u2 - 23 V1 - 499 V2 <= 0 326 U1 + 5 U2 - 19 V1 - 420 V2 <= 0 273 U1 + 5 U2 - 17 V1 - 689 V2 <= 0 284 U1 + 5 U2 - 34 V1 - 822 V2 <= 0 204 U1 + 5 U2 - 10 V1 - 501 V2 <= 0 273 U1 + 5 U2 - 11 V1 - 719 V2 <= 0 183 U1 + 5 U2 - 11 V1 - 262 V2 <= 0 204 U1 + 5 U2 - 13 V1 - 487 V2 <= 0 116 U1 + 5 U2 - 9 V1 - 173 V2 <= 0 467 U1 + 5 U2 - 50 V1 - 1096 V2 <= 0 257 U1 + 5 U2 - 30 V1 - 278 V2 <= 0 1302 U1 + 5 U2 - 48 V1 - 1265 V2 <= 0 290 U1 + 5 U2 - 11 V1 - 852 V2 <= 0 417 U1 + 5 U2 - 23 V1 - 1127 V2 <= 0 U1, U2, V1, V2 >= 0 END We use software LINDO Release 6.1 Demo Version.

The expression (3) is in LINDO format. The result is as follows. OBJECTIVE FUNCTION VALUE 1) 1.000000 VARIABLE VALUE REDUCED COST U1 0.001639 0.000000 U2 0.000000 0.000000 V1 0.058824 0.000000 V2 0.000000 0.000000 1.0.The score of efficiency for all DMUs can be found in Table 2. TABLE II RESULT OF EFFICIENCIES FOR EACH DMU USING OUTPUT-ORIENTED DEA NO DMU DEA SCORE 1 INFORMATION TECHNOLOGY 1,0 2 CIVIL ENGINEERING 0,6982436 3 ARCHITECTURAL ENGINEERING 0,6818709 4 INDUSTRIAL ENGINEERING 0,7045490 5 CHEMICAL ENGINEERING 0,8069085 6 MECHANICAL ENGINEERING 0,5265533 7 ELECTRICAL ENGINEERING 0,8263003 8 AGRIBUSINESS 0,6639550 9 AGROTECHNOLOGY 0,3810771 10 AQUACULTURE 1,0 11 COMMUNICATION SCIENCE 0,9912544 12 POLITICAL SCIENCE 0,9152225 13 SOCIOLOGY 0,7845375 14 ANTHROPOLOGY 1,0 15 JURISPRUDENCE 0,4226586 16 MEDICAL 1,0 17 MANAGEMENT 0,9921286 18 ECONOMIC DEVELOPMENT 1,0 19 ACCOUNTING 0,5871874 From Table 2 we would be able to observe that DMU1, DMU10, DMU14, DMU16, and DMU18 are efficient.

However if the output variable the number of research (y2) is increased significantly

then the corresponding DMU would be efficient. For example, DMU2 is inefficient. If y2 is increased from 5 to 15 then it would be efficient. DMU3 is inefficient formerly, if we increase y2 from 5 to 10, it would be efficient. It should be noted that the number of staff for DMU2 and DMU3, respectively, are 26 and 15.

In order to control the flexibility of output variables, it is necessarily to add the constraints in model (2) with bounded output. ???? = ?? ?? ?? ???? Where LB is lower bound and UB is upper bound for DMU j. IV. CONCLUSION The efficiency assessment of all Higher Education Institute in Aceh Province is carried out using CCR output oriented model.

The analysis of efficiency can be done by varying the output variables, while the input variables are kept fixed. Nevertheless the output variables should be upper bounded. It is found out that the main important in order to be efficient is to have more number of research. As a matter of fact this finding is synchronized with the urge from Indonesia Government about to have more research scheme. REFERENCES [1] C.L. Mei, H.C.

Huang, and W.K. Wang, "Designing a Knowledge- Based System forBenchmarking: A DEA Approach", Knowledge- Based Systems, vol. 24, pp. 662-671, 2011 [2] M.J. Farrell, 1957, "The Measurement of Productive Efficiency", Journal of The Royal Statistical Society Series A. General, vol. 120, pp. 253-281, 1957 [3] A. Charnes, W. W. Cooper, and E. Rhodes, European J. of Oper. Res, vol. 2, pp. 429-444, 1978 [4] C.K.Wei, L.C. Chen, R.K. Li, and C.H.

Tsai, "Exploration of Effiency Underestimation of CCR Model: Based on Medical Sectors with DEA- R Model", Expert Systems With Applications, vol. 38: pp. 3155-3160, 2011 [5] R. Lin, and Z. Chen, "Fixed Input Allocation Methods Based on Super CCR Efficiency Invariance and Practical Feasibility", Applied Mathematical Modelling, vol. 40: pp.

5377-5392, 2016 [6] T. Rosenmayer, T. "Review of Economic Perspectives", vol. 14, pp. 34-54, 2014 [7] N. Hussein, S. Omar, F. Noordin, and N.A. Ishak. "Learning Organization Culture, Organizational Performance and Organizational Innovativeness in a Public Institution of a Higher Education in Malaysia: A Preliminary Study". Procedia Economics and Finance, vol. 37, pp. 512-519, 2016 [8] H. Etzkowitz and C. Zhou.

"University-Industry-Government Interaction: the Triple Helix Model of Innovation". Asia Pacific Tech Monitor, vol. 24, pp. 14-23, 2007 [9] J. Johnes, J. and L. Yu, China Economic Review, vol. 19, pp. 679-696, 2008 [10] J. Du, J. Huo, and J. Zhu. "Data Envelopment Analysis with Output- Bounded Data". Asia-Pacific Journal of Operational Research, vol. 33 (6), pp. 1650050-1 - 1650050-17, 2016 [11] W.W. Cooper, J.T.

Pastor, F Borras, J Aparicio, and D Pastor, "BAM: A bounded adjusted measure of efficiency for use with bounded additive models", Journal of Productivity Analysis, vol. 35, pp. 85 – 94, 2011 [12] M. Branda, "Reformulations of Input-Output Oriented DEA Tests With Diversification", Operation Research Letters, vol. 41, pp. 516-520, 2013 [13] J. Wu, P. Yin, J. Sun, J. Chu, and L.

Liang, "Evaluating the Environmental Efficiency of a Two-Stage System with Undesired Outputs by a DEA Apprach: An Interest Preference Perspective", European Journal of Operational Research, vol. 35, 2016 [14] Y.G. Smirlis, E.K. Maragos, and D.K. Despotis. "Data Envelopment Analysis with Missing Values: An Interval DEA Approach", Applied Mathematics and Computation, vol. 177, pp. 1-10, 2006 [15] Y. M. Wang, R.

Greatbanks, and J. B. Yang. "Interval efficiency assessment using data envelopment analysis", Fuzzy Sets and Systems, vol. 153, pp. 347 – 370, 2005

INTERNET SOURCES:

1% - http://insightsociety.org/ojaseit/index.php/ijaseit/issue/view/48
<1% - http://cmr.asm.org/content/25/2/264.full
<1% - http://www.scielo.br/scielo.php?pid=S0100-15742006000200002&script=sci_arttext&tlng=en
<1% - https://www.york.ac.uk/che/pdf/DP177.pdf
1% - http://www.iiakm.org/ojakm/articles/2016/volume4_2/OJAKM_Volume4_2pp59-73.pdf
<1% - https://wenku.baidu.com/view/55c4add7c1c708a1284a44a6.html
<1% - http://www.inderscienceonline.com/doi/full/10.1504/IJSTL.2013.050595
<1% - https://www.hindawi.com/journals/tswj/2015/948793/
<1% - https://www.sciencedirect.com/science/article/pii/S0736585314000719
<1% - https://www.slideshare.net/AlexanderDecker/commercial-banks-efficiency-in-tanzania
<1% - http://www.tandfonline.com/doi/full/10.1080/09537325.2015.1024645?scroll=top&needAccess=true
<1% - https://www.brookings.edu/research/thirteen-economic-facts-about-social-mobility-and-the-role-of-education/
<1% - https://en.wikipedia.org/wiki/Higher_education_in_Finland
<1% - https://www.sciencedirect.com/science/article/pii/S2405883116300338

<1% - https://wikivisually.com/wiki/List_of_medical_schools_in_Indonesia
<1% - https://quizlet.com/32406482/ais-final-flash-cards/
<1% - https://www.newcastle.edu.au/profile/rebecca-mitchell
<1% - https://link.springer.com/article/10.1007/s11192-016-2013-3
1% - http://www.australianuniversities.com.au/directory/student-numbers/
<1% -
http://docplayer.net/24343951-Data-envelopment-analysis-and-performance-measurment-proceedings-of-the-11-th-international-conference-of-dea.html
<1% - http://ascelibrary.org/doi/10.1061/%28ASCE%29CO.1943-7862.0000484
<1% - http://ccsenet.org/journal/index.php/ibr/article/viewFile/45084/25147
1% - https://www.researchgate.net/profile/Mahmood_Mehdiloo
<1% - https://www.researchgate.net/profile/Choon_Ki_Ahn
<1% - https://link.springer.com/chapter/10.1007/978-90-481-9325-7_4
<1% - http://dl.acm.org/ft_gateway.cfm?id=378794&type=pdf
<1% - https://www.sciencedirect.com/science/article/pii/S0261517707000271
<1% - https://bmcnurs.biomedcentral.com/articles/10.1186/s12912-014-0036-8
<1% - http://www.science.gov/topicpages/e/envelopment+analysis+dea.html
<1% - https://jobs.brighton.ac.uk/Upload/vacancies/files/2103/EV3015-%20FPs.doc
<1% - https://www.rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=877
<1% -
https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/4714/Edokat,%20Umo%20&%20Udogu%20%20%20%20ZJER.pdf%3bsequence=1
<1% -
http://www.iosrjournals.org/iosr-jbm/papers/Vol18-issue9/Version-4/K1809047277.pdf
<1% - http://www.ijsrp.org/research-paper-1112/ijsrp-p1135.pdf
<1% - http://www.academia.edu/190387/Measurement_of_Efficiency_of_Banks_in_India
<1% - https://arxiv.org/pdf/1612.07857.pdf
<1% - https://www.sciencedirect.com/science/article/pii/S0306261914002323
<1% - https://readthedocs.org/projects/bumps/downloads/epub/v0.7.5.10/
<1% - http://www.iit.edu/~smile/guests/gsmxsec1.htm
<1% - https://link.springer.com/article/10.1007/s40070-015-0049-x
<1% - https://link.springer.com/article/10.1057/jors.2013.40
<1% -
https://www.researchgate.net/publication/259240980_Interval_data_without_sign_restrictions_in_DEA
<1% - https://dl.acm.org/citation.cfm?id=1643031.1643048
<1% -
http://www.sciencepublishinggroup.com/journal/paperinfo?journalid=171&doi=10.11648/j.jfa.20170506.13
1% - https://www.hindawi.com/journals/mpe/2018/3826096/

1% - http://ebpj.e-iph.co.uk/index.php/EBProceedings/article/view/180
1% - https://www.sciencedirect.com/science/article/pii/S0305048315000869
1% - https://link.springer.com/article/10.1007/s10617-016-9171-7
1% - https://personalpages.manchester.ac.uk/staff/jian-bo.yang/Journal_Papers.htm