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Time Series and Data Envelopment Analysis on The Performance Efficiency of Dmmmsu-South La Union Campus

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Abstract. This study entitled "Time Series and Data Envelopment Analysis (DEA) on the Performance Efficiency of DMMMSU-South La Union Campus" determined the performance of the Don Mariano Marcos Memorial State University -South La Union Campus, La Union, Philippines, a Level Four state university in the country, vis-à-vis its efficiency along the following performance indicators: Program Requirements, Research, Extension and Production for five (5) academic years 2009-2014. Furthermore, it determined the peer groups and weights of the DMUs (Decision Making Units – the different Colleges and Institutes), the virtual inputs/outputs or potential improvements of the colleges/institutes to be in the efficient frontier, the input and output slacks (input excesses and output shortfalls)needed in the different indicators and the best practices to be considered by the inefficient and weak efficient DMUs. The "best practice" in the frontier is the basis to calculate the adjustments necessary for the DMUs. Different indicators showed varied performance levels in the different academic years but there are best practices from the "efficient" DMUs which could be adapted by the "weak efficient" and "inefficient" ones

Keyword: Data Envelopment Analysis, Performance Efficiency

Abstrak. Studi yang berjudul "Time Series and Data Envelopment Analysis (DEA) on the Performance Efficiency of DMMMSU-South La Union Campus" ditentukan performa dari Don Mariano Marcos Memorial State University South La Union Campus, La Union, Philippines, ada beberapa indikator performa efisiensi yaitu: Kebutuhan program, penelitian, perpanjangan dan produksi selama jangka waktu 5 tahun yaitu 2009-2014. Selanjutnya, ditentukan kelompok dan bobot DMU (Unit Pengambilan Keputusan - Kolese dan Institusi yang berbeda), input / output virtual atau peningkatan potensial perguruan tinggi / institusi berada di perbatasan yang efisien, kekurangan input dan output dibutuhkan pada berbagai indikator yang berbeda dan praktik terbaik yang harus dipertimbangkan oleh DMU yang tidak efisien ."Praktik terbaik" di perbatasan adalah dasar untuk menghitung penyesuaian yang diperlukan untuk DMU. Indikator yang berbeda menunjukkan tingkat kinerja yang bervariasi di tahun ajaran yang berbeda namun ada praktik terbaik dari DMU "efisien" yang dapat disesuaikan dengan yang "lemah efisien" dan "tidak efisien".

Kata Kunci: Analisis Data Envelopment, Performa Efisiensi

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1. Introduction

The wave of the times and call on "quality" of higher education rose from the growing diversity of institutions and millennium students; the declining public support are always of positive development. This leads universities and colleges, be it private or public/state, to be conscious and aware of their academic and non-academic activities for quality and effectiveness in the delivery of education through their departments and staff, more sensitive to the ways of strengthening the programs and themselves and be more motivated to act towards the improvement of all their functions.

Institutional autonomy is a necessary measure for a sufficient and effective condition to develop a "culture of excellence". Culture of excellence embodies a wide range of quality control mechanisms, including internal reviews, through which academic excellence is achieved and sustained. Thus, quality assurance is instituted.

The strategic approach to quality assurance is based on developing the capacity of higher education institutions to design and deliver high quality programs to meet the needs of the country and which achieve standards comparable to those of universities in other countries with which the country competes [1].

The criteria used to assess the quality of work in colleges and universities are closely linked to their varying missions. Institutional missions become more diverse as mass higher education develops. The culture of excellence in a prime teacher education college or university needs not be keyed to the same criteria of quality used to assess work in leading research universities, and it may be supported by different procedures and mechanisms.

In the Philippines, the higher education system is a key player in the educational and integral formation of professionally competent, service-oriented, principled and productive citizens. It has a tri-fold function of teaching, research and extension services. Through these, it becomes a prime mover of the nation's socio-economic growth and sustainable development.

The role of a tertiary education institution are varied and viewed in different perspective such as: (1) preservation and transmission of knowledge; (2) operating as a service enterprise that provides instruction, training and services in response to consumer demands; (3) a producer in human resources to satisfy the trained manpower needs of the community; and (4) as an institution that provides instruction, research and public services to its consumers [1].

In this regard, the Commission on Higher Education (CHED) is mandated and responsible for formulating and implementing policies, plans and programs for the efficient operation of the system of higher education in the country. It is attached to the Office of the President for

Administrative purposes only. It covers both public and private institutions of higher education as well as degree-granting program post-secondary public and private educational institutions.

Missions of the higher educational system are to educate and train Filipinos for enhanced labor productivity and responsible citizenship. This is to institute an environment where educational access is equitable and to inculcate nationalism and patriotism in the hearts and minds of the students and graduates.

Furthermore, the Commission on Higher Education is mandated to accelerate the development of high-level professionals ready to meet international competition and to serve as Centers for Research and Development. The CHED recognizes the enormous contribution of higher education institutions in the growth and prominence of tertiary education in the country and in the Asia- Pacific.

To improve the quality of instruction delivered by the tertiary education institutions, CHED encourages institutions to seek accreditation and provide a number of incentives in the form of progressive deregulation, grants and subsidies to institutions with accredited programs.

As part of its mandate, CHED monitors and evaluates HEIs in the country through Republic Act 7722. Its purposes are: (a) to make judgment about the effectiveness of the institution and (b) to ensure the quality of standards and programs. In addition, it has a renewed push for quality assurance particularly: (a) movement to mass higher education; (b) emerging new challenges; (c) workforce has become global and geographically fluid and (d) development of advanced information and communication technologies.

There are different mechanisms of quality assurance. There are program-based like the authority to grant permit/recognition, standards setting, accreditation, international certifications, Center of Development/Excellence and international benchmarking. Institution-based mechanisms include Institutional Quality Assurance Monitoring and Evaluation (IQUAME), SUC leveling, Philippine Quality Award, Autonomous and Deregulated Status of HEIs, PSG for university status and Local Colleges and Universities (http:/ www.ched.gov.ph).

At the institutional level, CHED has developed the following mechanisms: for State Universities and Colleges Leveling. This has been set to determine the overall performance of the HEIs in different aspects for classification or categorization of institutions based on the various levels of quality [2].

Assessing the performance of educational institutions vis-à-vis attainment of their stated objectives is fraught with difficulties. As an alternative measure, the performance of universities has been assessed using a systemic model (input-output processes) concentrating on the means of attaining the objectives through indicators as: outputs of the organization, administrative and

technological processes, and the quality and quantity of inputs used. In general, universities are committed to the traditional goals of preserving and transmitting knowledge, extending the frontiers of knowledge and applying knowledge [3].

Private and public institutions like colleges and universities need to be assessed. Performance indicators have often been criticized for being inadequate and not conducive to analyzing efficiency. The measurement of organizational performance and efficiency is an essential part of the reform for the general welfare of all groups as well as the country. The measure of efficiency is the possible evaluation of the performance of an organization by comparing it with the standards of international best practice [4].

The concepts of institutional performance are the embodying components on two dimensions: effectiveness -is the congruence between outputs and goals or other criteria; and on one hand, efficiency - links outputs with inputs. The efficiency dimension, has been relatively neglected to assess institutional performance, is further they defined Efficiency's relationship to the economic concepts of productivity is examined. The practical difficulties in assessment related to the conceptualization and measurement of inputs and outputs has to reflect in the educational institution's purposes and processes. The results are used as management information for action.

Some researches review the progress toward overcoming these difficulties and examine the ways that recent research addresses the analytical problems of assessing the input-output component of institutional performance. Studies of input-output relationships are classified into three categories: (1) input-output-ratio studies, which include the use of cost-analysis techniques and "productivity" ratios; (2) regression studies, which use statistical procedures to estimate the typical relationships among the variables; and (3) production frontier or data envelopment techniques, which identify and explore the most desirable input-output combinations or estimate the feasible range of these combinations [1]

2. The Don Mariano Marcos Memorial State University: A Background on Quality

One of the known CHED supervised state university in the Philippines is the Don Mariano Marcos Memorial State University (DMMMSU) in La Union. Since its existence, DMMMSU has been performing as one of the best state universities in the Philippines. This is reflected in the latest report on the leveling of universities with DMMMSU as one of the top ten (10) Level IV State Universities and Colleges (SUCs) and among the 107 state higher education institutions [5].

Recently, an institutional self-evaluation was conducted by a team of evaluators composed of administrators and senior faculty members in the university. The study conducted aimed to determine the performance level of the institution and the significant factors which affected its performance. Specifically, it looked into the performance level of the 16 colleges and institutes

along 8 performance indicators namely: program requirements, planning, curriculum and instruction, student development and services, physical plant and facilities, research, extension and resource generation and utilization. The study further aimed to provide direction to planning and to serve as a basis for the improvement of the existing policies and practices of the institution.

The main tool of the study was an instrument developed by a team of evaluators and approved by the University Administrative Council through Resolution No. 35, s. 2007. It made use of 8 performance indicators with sub-indicators and their corresponding points. Secondary data were obtained through interviews, documents and reports of programs and projects. A combination of four designs was used namely: quantitative, descriptive, relational, co-relational and cross sectional designs. Frequency counts and percentages, pair-wise regression and bivariate correlation analysis were utilized in the study.

In the study on the performance of the 16 colleges and institutes of DMMMSU, the strengths and weaknesses of the colleges and institutes were uncovered. It revealed that the general performance level of the entire university was "barely performing" and that the five factors that significantly affected its performance were Resource Generation, Research, Extension, Program Requirements and Student Development and Services. The strongest, however, were Planning and Physical Facilities. In terms of the performance of the 16 colleges and institutes of the university mentioned, there were two "highly performing", five "moderately performing", seven "fairly performing," and two "barely performing" with the College of Education of the South La Union Campus as the highest performing college.

The results have been considered by the researcher, thus, this paper regarding the performance vis-à-vis the efficiency of the 16 colleges and institutes of the same university has been conceptualized. Furthermore, the evaluation was done through Data Envelopment Analysis (DEA) along different performance indicators namely Program Requirements, Instruction, Research, Extension and Others (Annual Budget). It also analyzed the indicators and sub-indicators where the colleges and institutes performed efficiently and inefficiently. Within this context, the university has embarked on improving the areas where the colleges and institutes did not perform efficiently, thus the need for this study.

The paradigm of the study shows the DMUs in the input box – the campus with its four (4) colleges namely College of Education (CE), College of Arts and Sciences (CAS), College of Computer Science (CCS) and College of Graduate Studies (CGS) and its three (3) institutes namely Institute of Agriculture (IA), Institute of Fisheries (IF) and Institute of Community Health and Allied Medical Sciences (ICHAMS). In the process box is the analysis of data along the four-fold functions of the university – Program Requirements under Instruction (Input variable – number of programs, output – accreditation status), Research (input - number of researches,output - number of patented researches, number of researches presented in the international fora and

other types of fora, number of research awards received and number of researches published in refereed journals) Extension (input -number of trainings conducted,output -number of clientelesserved) and Production (input variable- number of income generating projects, output - income generated). These variables are treated using Data Envelopment Analysis. Finally, in the output box is the Performance Efficiency of the DMUs which would reflect their best practices to be in the efficient frontier to serve as a feedback to the DMUs.

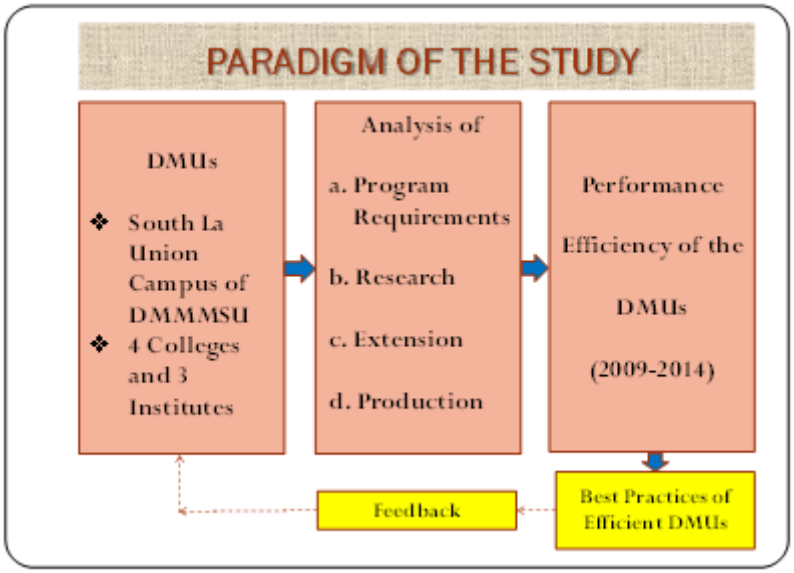


Figure 1. Paradigm of the Study

3. Research Question

The main objective of the study is to determine the performance efficiency of the different colleges and institutes of DMMMSU-South La Union Campus along Program Requirements, Research, Extension and Production. Specifically, based on the different indicators, this study will seek answers to the following questions:

1. What is the efficiency of the different colleges and institutes based on the DEA and Time Series Analysis?
2. What are the peer groups and weights of the DMUs?
3. What are the virtual inputs/outputs or improvements of the DMUs to be in the efficient frontier?
4. What are the input and output slacks needed in the different indicators?
5. Based on the findings, what are the best practices to be considered by the efficient DMUs?

4. Methodology

The study was a documentary analysis that utilized the descriptive evaluative research design considering several entities for evaluation using a non-parametric approach and non-statistical

method called Data Envelopment Analysis (DEA) in Decision Making Units (DMUs). DEA is a linear programming based technique for measuring the relative performance of organizational units where the presence of multiple inputs and outputs makes comparisons difficult. This introduces the technique and uses an example to show how relative efficiencies can be determined and targets for inefficient units set. It is also accompanied by Time Series Analysis. It further employed the Output Oriented Multi - Stage DEA Constant Returns-to-Scale (CRS) Model.

Performance efficiency of the DMUs was categorized into three (3): Fully Efficient, Weak Efficient and Inefficient. Fully efficient DMUs have an efficiency score of 1.000 and they no longer need improvements, weak efficient DMUs on the other hand have efficiency scores of 1.000 but they still need potential improvements to be in the efficient frontier while inefficient ones need a lot of improvements. Fully efficient DMUs are found in the efficient frontier.

5. Findings

The following were the findings of the study:

(1) The performance efficiency of the campus is as follows:

a. As to Program Requirements, only the College of Education was the only academic unitfound to be fully efficient with an efficiency score of 1.00. All the other units were inefficient which means they still lack other requirements like having a higher accreditation status to be fully efficient. On the other hand, ICHAMS has the lowest efficiency score since it had the lowest accreditation status during the evaluation period.

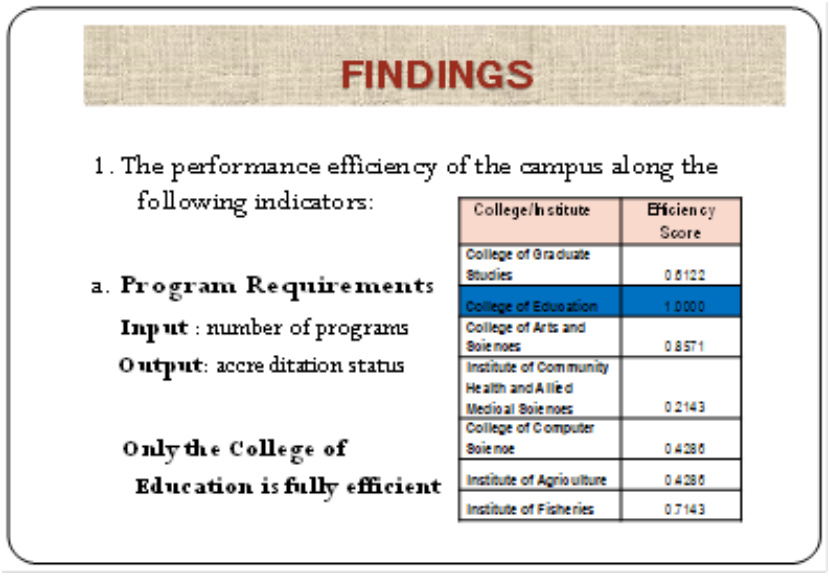
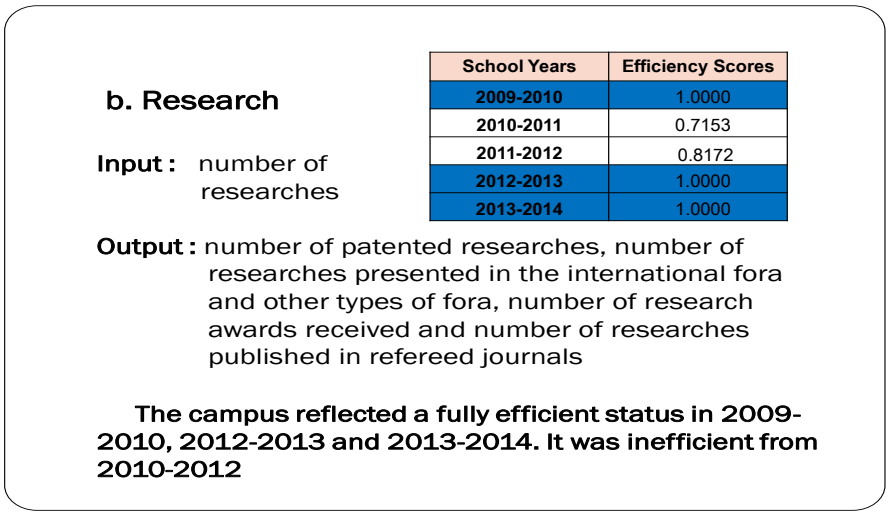


Figure 2. Indicator Performance Efficiency

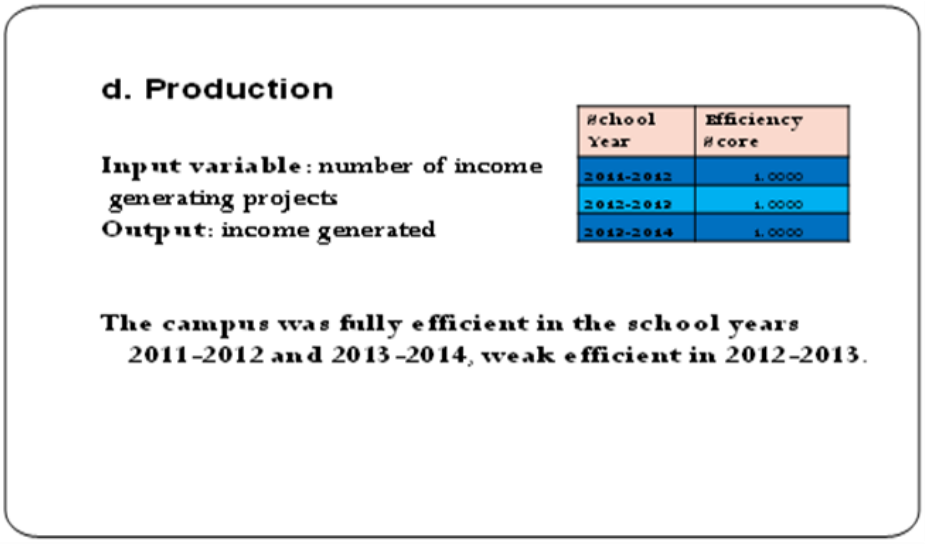
b. In Research, the campus reflected a fully efficient status in 2009- 2010, 2012-2013 and 2013-2014. It was inefficient from 2010-2012. This is due to the low output like number of patented researches, paper presentations in the different fora, publications and awards received in the said indicator.



School Years	Efficiency Scores
2009-2010	1.0000
2010-2011	0.7153
2011-2012	0.8172
2012-2013	1.0000
2013-2014	1.0000

Figure 3. Research Input and Research Output

c. In Production, the campus was fully efficient in the school years 2011-2012 and 2013-2014 and weak efficient in 2012-2013. Although it had an efficiency score of 1.00 in 2012-2013, it is because of the low income generated compared to the other years.

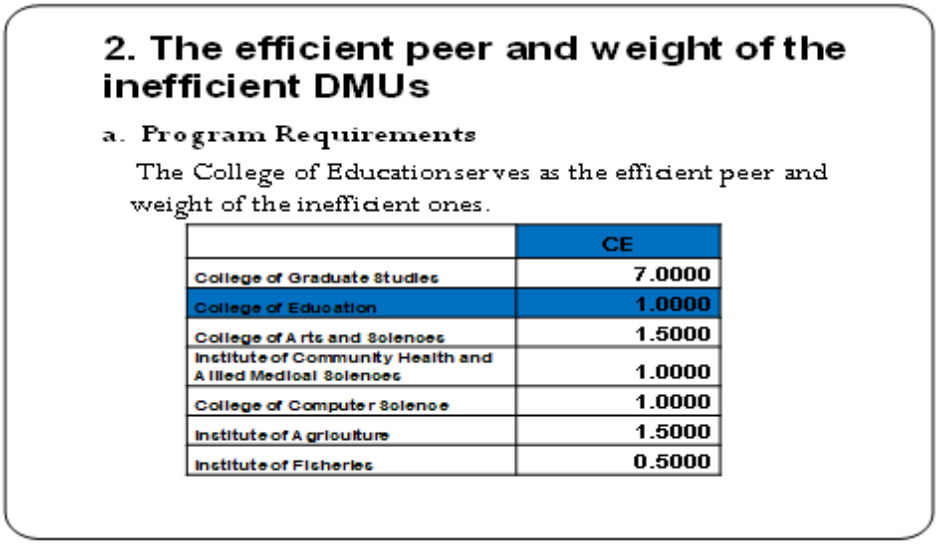


#chool Year	Efficiency #core
2011-2012	1.0000
2012-2012	1.0000
2012-2014	1.0000

Figure 4. Campus Production

(2) The efficient peer and weight of the inefficient DMUs are:

a. The College of Education is the efficient peer and weight of the other academic units for Program Requirements since it was the highest in terms of accreditation status.



2. The efficient peer and weight of the inefficient DMUs

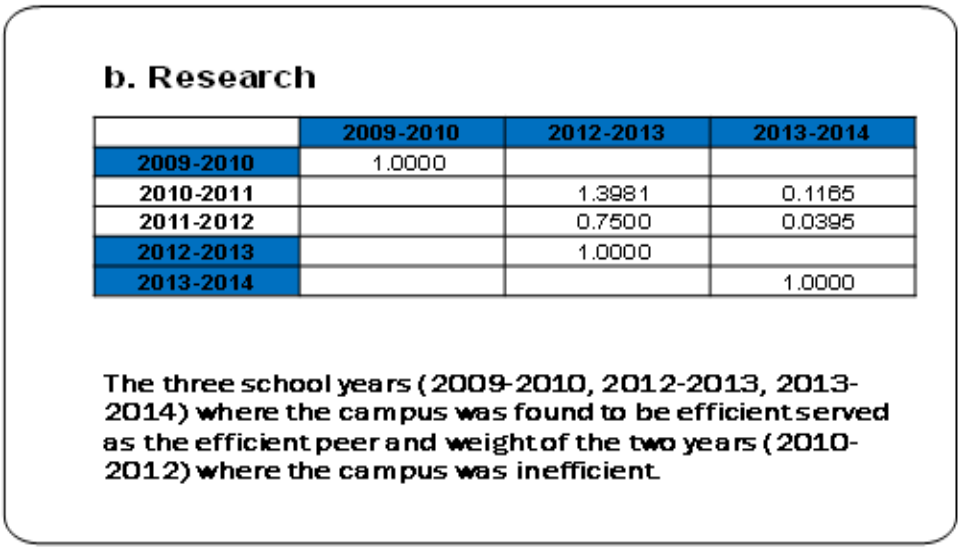
a. **Program Requirements**

The College of Educationserves as the efficient peer and weight of the inefficient ones.

	CE
College of Graduate Studies	7.0000
College of Education	1.0000
College of Arts and Sciences	1.5000
Institute of Community Health and Allied Medical Sciences	1.0000
College of Computer Science	1.0000
Institute of Agriculture	1.5000
Institute of Fisheries	0.5000

Figure 5. Program Requirement

b. The three school years (2009-2010, 2012-2013, 2013-2014) where thecampus was found to be efficient served as the efficient peer and weight of the two years (2010-2012) where the campus was inefficient; there is a need to imitate the best practices during those years to be in the efficient frontier.



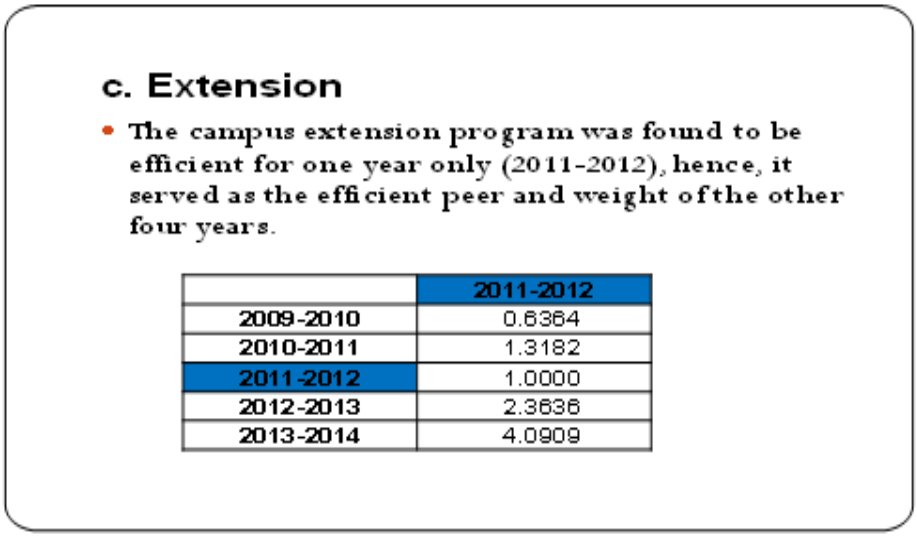
b. Research

	2009-2010	2012-2013	2013-2014
2009-2010	1.0000		
2010-2011		1.3981	0.1165
2011-2012		0.7500	0.0395
2012-2013		1.0000	
2013-2014			1.0000

The three school years (2009-2010, 2012-2013, 2013-2014) where the campus was found to be efficient served as the efficient peer and weight of the two years (2010-2012) where the campus was inefficient.

Figure 6. Research in 3 years

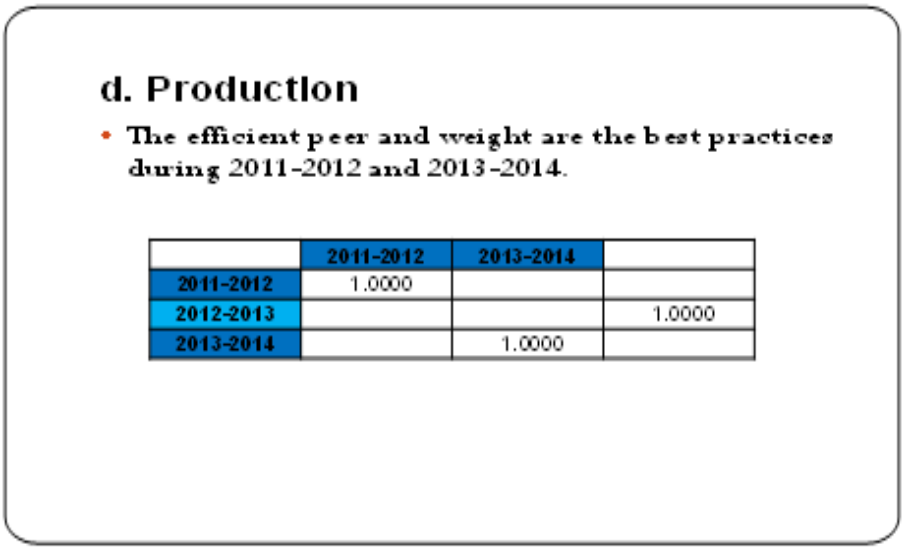
c. The campus extension program was found to be efficient for one year only (2011-2012), hence, it served as the efficient peer and weight of the other four years;



	2011-2012
2009-2010	0.6364
2010-2011	1.3182
2011-2012	1.0000
2012-2013	2.3636
2013-2014	4.0909

Figure 7. Extension

d. The efficient peer and weights are the best practices during 2011-2012 and 2013-2014 in Production. In 2012-2013,

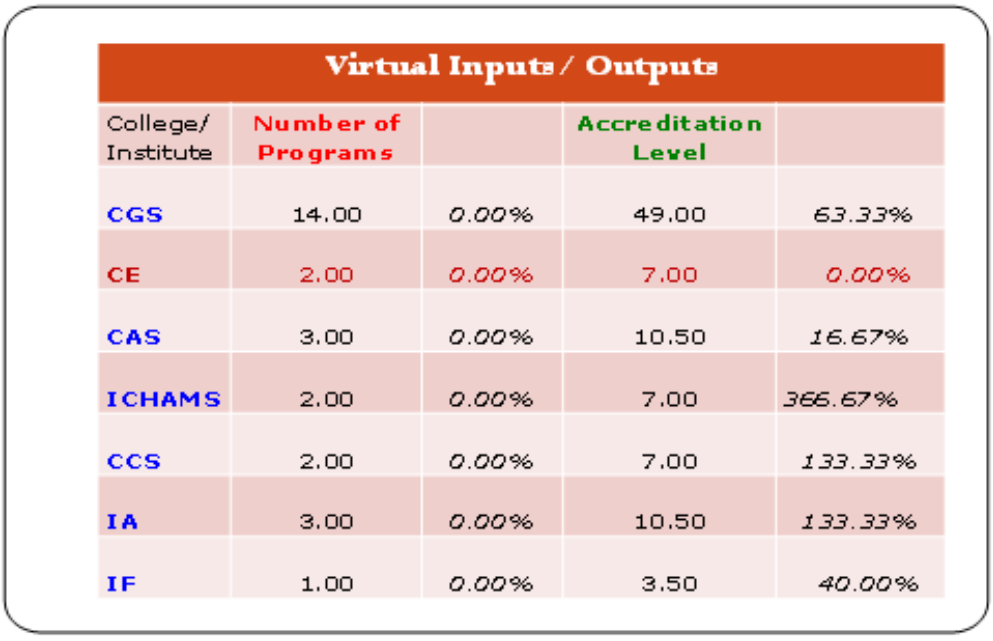


	2011-2012	2013-2014	
2011-2012	1.0000		
2012-2013			1.0000
2013-2014		1.0000	

Figure 8. Production the Efficient peer

(3) The virtual inputs/outputs or improvements of the colleges/institutes to be in the efficient frontier (Potential Improvement of the DMUs) are the following:

a. Program Requirements - except for the College of Education, all the other colleges and institutes need potential improvements in the accreditation level.

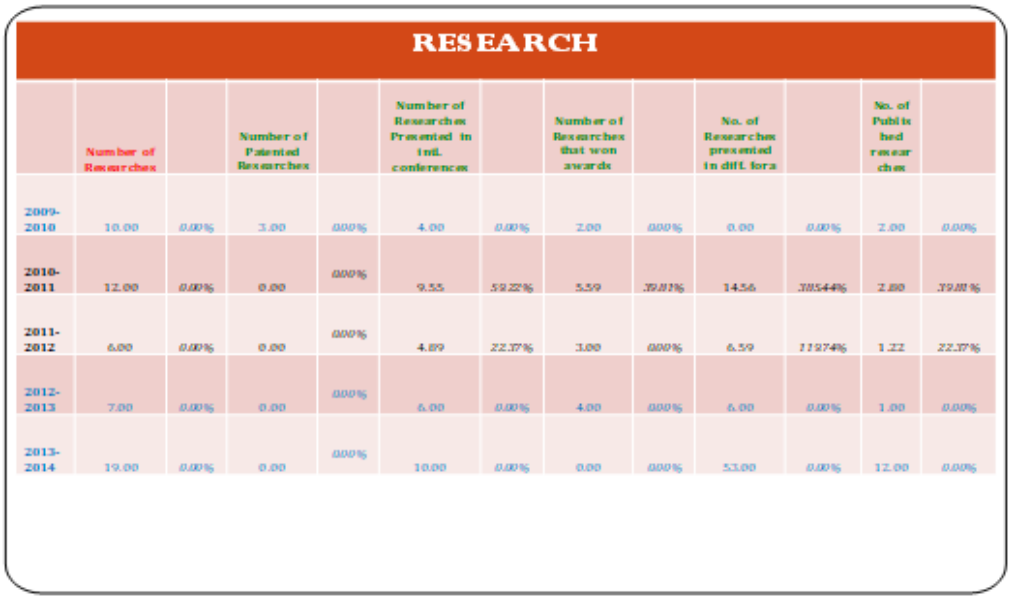


Virtual Inputs / Outputs

College/ Institute	Number of Programs		Accreditation Level	
CGS	14.00	0.00%	49.00	63.33%
CE	2.00	0.00%	7.00	0.00%
CAS	3.00	0.00%	10.50	16.67%
ICHAMS	2.00	0.00%	7.00	366.67%
CCS	2.00	0.00%	7.00	133.33%
IA	3.00	0.00%	10.50	133.33%
IF	1.00	0.00%	3.50	40.00%

Figure 9. Virtual Input and Output

b. Improvements in the outputs are needed in the school years 2010- 2011 and 2011-2012 in Research.



RESEARCH

	Number of Researchers		Number of Patented Researchers		Number of Researchers Presented in Intl. conferences		Number of Researchers that won awards		No. of Researchers presented in diff. fora		No. of Published researchers	
2009-2010	10.00	0.00%	3.00	0.00%	4.00	0.00%	2.00	0.00%	0.00	0.00%	2.00	0.00%
2010-2011	12.00	0.00%	0.00	0.00%	9.55	59.22%	5.59	39.81%	14.56	38544%	2.80	39.81%
2011-2012	6.00	0.00%	0.00	0.00%	4.89	22.37%	3.00	0.00%	6.59	11974%	1.22	22.37%
2012-2013	7.00	0.00%	0.00	0.00%	6.00	0.00%	4.00	0.00%	6.00	0.00%	1.00	0.00%
2013-2014	19.00	0.00%	0.00	0.00%	10.00	0.00%	0.00	0.00%	53.00	0.00%	12.00	0.00%

Figure 10. Research Improvement

c. Extension - except for 2011-2012, improvements are needed in the number of clienteles for the other school years.

Virtual Inputs/Outputs

	Number of Trainings Conducted		Number of Clienteles served	
2009-2010	14.00	*0.00%*	652.91	*80.36%*
2010-2011	29.00	*0.00%*	1,352.45	*1.84%*
2011-2012	22.00	*0.00%*	1,026.00	*0.00%*
2012-2013	52.00	*0.00%*	2,425.09	*29.82%*
2013-2014	90.00	*0.00%*	4,197.27	*21.52%*

Figure 11. Virtual Input/ Output Extension

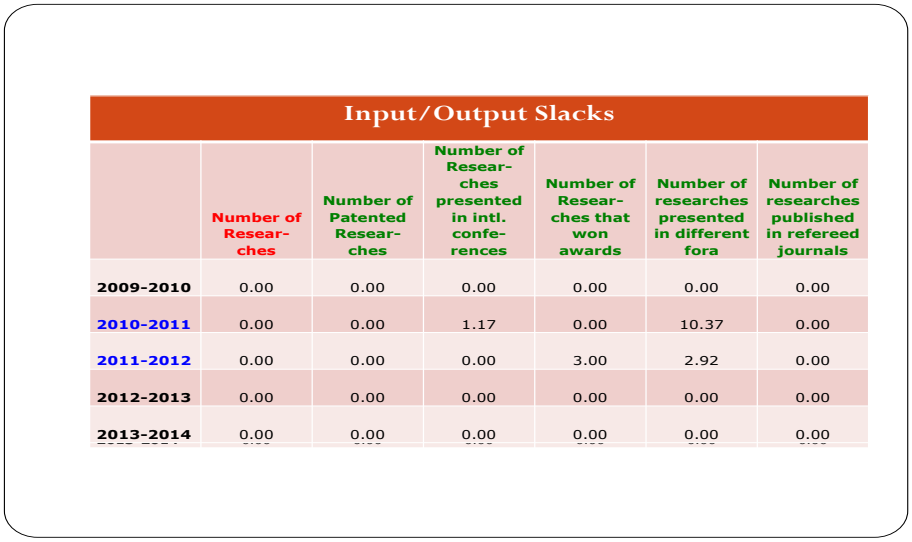
d. Production - Improvement is needed for the output - income generated in SY 2012-2013.

Virtual Inputs/Outputs

	Agoo		Rosa-rio		Sto To-mas		In-come Gene-rated - Agoo		In-come Gene-rated – Sto. To-mas		In-come Gene-rated – Rosa-rio	
2011-2012	14.00	*0.00%*	9.00	*0.00%*	11.00	*0.00%*	784,091.94	*0.00%*	795,728.00	*0.00%*	122,042.09	*0.00%*
2012-2013	13.00	*0.00%*	10.00	*0.00%*	8.00	*0.00%*	768,328.33	*0.00%*	812,883.02	*0.00%*	123,742.91	*0.00%*
2013-2014	11.00	*0.00%*	10.00	*0.00%*	4.00	*0.00%*	143,577.42	*0.00%*	590,095.69	*0.00%*	50,788.19	*0.00%*

Figure 12. Virtual Input/ Output Production

(4) The input/output slacks were needed only in Research in 2010-2012.



Input/Output Slacks						
	Number of Resear-ches	Number of Patented Resear-ches	Number of Resear-ches presented in intl. confe-rences	Number of Resear-ches that won awards	Number of researches presented in different fora	Number of researches published in refereed journals
2009-2010	0.00	0.00	0.00	0.00	0.00	0.00
2010-2011	0.00	0.00	1.17	0.00	10.37	0.00
2011-2012	0.00	0.00	0.00	3.00	2.92	0.00
2012-2013	0.00	0.00	0.00	0.00	0.00	0.00
2013-2014	0.00	0.00	0.00	0.00	0.00	0.00

Figure 13. The input/output slacks

(5) Based on the findings, the best practices to be considered by the inefficient and weak efficient DMUs are:

a. Program Requirements – The inefficient DMUs need to have all their programs accredited to a higher status.

b. Research – the campus has to improve in the following areas: increase the number of research presentations in different fora and in national and international conferences, make quality researches that could win awards and they should publish papers in different refereed journals

c. Extension – increase the number of clienteles/beneficiaries served

d. Production – Agoo has to increase its income generated from the different projects.

6. Recommendations

The findings in the study may give impetus to the Commission on Higher Education (CHED) lawmakers or legislators and the university administrators to adopt measures that would be beneficial to the improvement of DMMMSU mandates from its inefficiency. In the light of the different findings, the following are recommended by the researcher:

1. For efficiency, the deans and directors of the 4 Colleges and 3 Institutes should be encouraged to submit their programs for higher accreditation status/level. The faculty and students have to work hard to earn awards in their respective fields of specialization, design and plan programs of completed researches to be presented in research fora (local, regional, national or international) for information dissemination.

2. A broader perspective of Extension is necessary for a greater number of clients is highly recommended.
3. Design and plan for Income Generating Projects in the South La Union Campus to increase the income generated to maintain/sustain the PS and MOOE funds. The efficient college/institute should share their best practices for an optimal operation of a model University.
4. The colleges/institutes are advised to re-assess their virtual Inputs-Outputs (IOs) particularly on the performance indicators to determine targets and percentages of IOs, increase/decrease in the different performance indicators to become efficient in its different mandates/functions.
5. All colleges/institutes of the University should work towards becoming a model in efficiency and for one to be in the efficient frontier. Virtual IOs should be considered and they should adapt the best practices of their efficient peers/references in the different performance indicators to catch up with the aimed efficiency frontier of 1.000.
6. Lastly, future studies may venture on other factors/variables/indicators to test the efficiency of the programs, industries and also the performance of their institutions/organizations.

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