

# MEASURING THE PUBLIC SPENDING PERFORMANCE ON HIGHER EDUCATION AT THE UNIVERSITY OF M'SILA, ALGERIA, IN TERMS OF EFFICIENCY AND EFFECTIVENESS USING DEA

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## **Abstract**

The purpose of this study is to measure the performance of public spending on higher education at University of M'Sila (U-M), in terms of efficiency and effectiveness using DEA, as well it aims to provide suggestions for further improvement using data from Vice Rectorate of Higher Education at the Undergraduate and Graduate Level, Continuing Education and Diplomas, and Graduate Training- and Sub-Directorate of Budget and Accounting of the U-M.

The data show that over the period 2014-2018 there are a continuous increase in the number of students enrolled led to increases in the funds allocated to the U-M faculties and institutes. This is due to the facilitation and the free of access to University in Algerian education. The data envelopment analysis DEA has been used for computing the efficiency and effectiveness of public spending on higher education scores for the U-M faculties and institutes. The overall public spending performance on higher education has been derived by multiplying their respective efficiency and effectiveness scores.

The estimated results reveal that the U-M faculties and institutes must have the potential to increase their outputs to improve their efficiency and effectiveness, that may improve their performance either by the efficiency or effectiveness or both of them. Only Humanities and Social Sciences faculty in the year 2018 have been found to be efficient in the stage I, and fully effectiveness in the year 2014, in the stage II, by scoring the first. A positive and strong correlation seems to be seen between efficiency, effectiveness and performance of public spending on higher education scores.

**Keywords:** Efficiency, Effectiveness, Performance, Public Spending, Higher Education.

**JEL classification:** C61, C67, G28, H52

## 1. INTRODUCTION

The task of the public sector as part of the macroeconomic flow model is to produce public goods and services primarily for collective consumption, which is called the public good (Batare, 2012). The use of the word public to describe products that are not competitive in consumption almost seems to prejudge the question of whether they should be supplied by the public sector (Rosen, 1999). A public good has a collective character. Moreover, when used by one person, others who have not indulged in consumption also benefit, meaning that the external effect has been created (Batare, 2012).

Education can be cited as one of the best examples of the positive external effect, and one of the most important items in government budgets, plays a vital role in an economy, as educated individuals benefit society in his outfit. Many countries around the world fund their higher education (HE) systems out of public funds and Algeria is not an exception.

In Algeria, education for all levels is primarily a service provided by the government. For higher education, there are many public colleges and universities, which fully fund their activities with public expenditure.

The good performance of the higher education system has always been a key issue for researchers and policy makers responsible for ensuring a strong and economically developed nation. Given the higher education and limited research in this area, our study focuses on measuring the performance of public expenditure in higher education at University of M'sila, in terms of efficiency and efficiency using DEA, and aims to provide suggestions for further improvements. In addition, its academic contribution, the results of this study would help governors to develop appropriate policies and guide managers in taking strategic measures to improve the performance of public spending at the faculties and institutes at the University M'sila.

The outline of this issue is organized as follows: the following section provides the framework for the review of the literature and the concepts. The second illustrates the methodology of the study. In the last section, an empirical study and results, we discuss the data and the source of the sample, the software used to calculate the efficiency and effectiveness of the DEA, the result of the evaluation U-M faculties and institutes, and process improvement.

## 2. LITERATURE REVEIW AND CONCEPTS

Efficiency and effectiveness are the central terms used to assess the performance of an organization (Mouzas, 2006). Performance, in profit and non-profit organizations, can be defined as an appropriate combination of efficiency and effectiveness (Kumar et al, 2010).

Efficiency refers to the relationship between inputs and outputs. A more efficient system obtains more output for a given set of resource inputs, or achieves

comparable levels of output for less input, education output refers to the portion of student growth or development which can reasonably be attributed to specific educational experiences (Marlaine, 1989).

Efficiency relates the input or the product to the final objectives to be achieved (Mandl et al, 2008). This means that effectiveness indicates the extent to which an organization's political goals are achieved. Educational effectiveness is whether or not a specific set of resources has a positive effect on success, and if so, what is the magnitude of that effect (Marlaine et al, 1994). In the vast majority of cases, non-monetary inputs imply efficiency and monetary inputs imply efficiency (Marlaine, 1989).

It is important to note that while efficiency and effectiveness are two mutually exclusive components of measuring overall performance, they can nevertheless influence each other. More specifically, effectiveness can be affected by efficiency or can influence efficiency as well as have an impact on overall performance (Ozcan, 2008). Nonetheless, measuring the efficiency and effectiveness of public spending remains a conceptual challenge, that what we going to prove it in the faculties and institutes at the U-M. Problems may arise as mentioned by (Mandl et al, 2008) that public spending has multiple purposes and so public sector products are often not sold in the market. Furthermore, one of the main goals of education policy is to improve educational outcomes, if resources are used inefficiently, they will fail to maximize the outcomes (Kosor, 2019).

### 3. METHODOLOGY

As stated in the literature review and the concepts, the DEA method is to be used to calculate the efficiency and effectiveness scores of U-M faculties and institutes. In the non-parametric approach, DEA is widely applied to measure efficiency (Sharma et al, 2013).

The DEA used by Charnes, Cooper and Rhodes, is a methodology for analysing the relative efficiency and management performance of production units having the same multiple inputs and outputs and sharing the same goals and objectives (Charnes, Cooper and Rhodes, 1978). According to Charnes, Cooper and Rhodes, DEA is also a mathematical programming approach (CCR model) to achieve relative efficiencies within a group of decision-making units (DMUs) (Charnes, Cooper and Rhodes, 1978). In their original study, (Charnes, Cooper and Rhodes, 1978) have describes the DEA as a: "A mathematical programming model applied to observational data that provides a new way to obtain empirical estimates of relationships - such as production functions and / or efficient production possibility surfaces - that are the cornerstones of the modern economy" (Bouguerra et al, 2012).

The DEA calibrates the efficiency level on the basis of a discrete piecewise estimated frontier (or what is called best practice or efficient frontier or enveloping surface) consisting of a set of Pareto efficiency DMUs. In all cases, these Pareto-efficient DMUs located on the efficient frontier, in relation to the others, minimize

the use of productive resources taking into account outputs (input-oriented measurement), or maximize outputs taking into account inputs (output-oriented measurement) (Kumar et al, 2010).

## 4. EMPIRICAL STUDY

### 4.1 DATA AND SAMPLE

Algerian universities are public institutions and scientific, cultural and professional organizations, endowed with corporate status and government spending. They are made up of governing bodies (board of directors, scientific council), faculties, institutes and annexes; common administrative and technical services. Algeria was faced with the challenge of the globalization of the university education system, which favoured the introduction of the LMD system (bachelor, Master and Doctorate). This reform has led to a major overall of the curricula and to new teaching practices. Maximizing opportunities and opening up to the international scene was the main reason for choosing the LMD system. This is why, in 2004, Algeria changed from the classical system (bachelor (License) within 4 years, Magister within 2 years, Doctorate between within 4 years) to the new system LMD (bachelor (License) within 3 years (License), Master within 2 years and doctorate within 3 years).

University of M’sila, established in 1985, is a public multidisciplinary higher education institution. Today it has more than 35,290 registered students, 1,471 full professors and 1,328 technical and administrative staffs. In addition to two national institutes: Management of urban techniques - Science and technology of physical and sports activities, the university hosts seven faculties: faculty of Technology, faculty of Sciences, faculty of Mathematics and computing, faculty of Law and political sciences, faculty of Economics and management sciences, faculty of Letters and languages and faculty of Human sciences and social Sciences (University of M’sila, 2020).

The table(1) below represent a set of statistics shows the evolution of students graduated in the period 2014-2019 at University of M’ Sila U-M.

**Table 1.** The evolution of students graduated at U-M in the period 2014-2019

years	2013-2014			2014-2015			2015-2016			2016-2017			2017-2018			
Faculties and Institutes	licen ce	Mas ter	Σ	licen ce	mas ter	Σ	licen ce	mas ter	Σ	licen ce	mas ter	Σ	licen ce	mas ter	Σ	Σ
Mathem atics and Comput er sciences	478	80	558	487	98	585	314	133	447	305	161	466	317	110	427	2483
Manage ment of Urban Techniq ues	498	24	522	220	107	327	127	146	273	97	193	290	174	205	379	1791
Science	578	125	703	647	214	861	832	232	1064	663	190	853	839	353	1192	4673

Technology	374	221	595	326	259	585	309	330	639	410	341	751	662	292	954	3524
Humanities and Social Sciences	1041	182	1223	1042	487	1529	806	654	1460	707	729	1436	1339	574	1913	7561
Letters and Languages	1536	136	1672	1681	381	2062	981	500	1481	993	649	1642	1189	490	1679	8536

years	2013-2014			2014-2015			2015-2016			2016-2017			2017-2018			Σ
Faculties and Institutes	Licence	master	Σ	licen ce	mast er	Σ	licen ce	mast er	Σ	licen ce	mast er	Σ	licen ce	mast er	Σ	
Science and Technology of Physical and Sports Activities	714	125	839	906	306	1212	312	320	632	303	345	648	372	140	512	3843
Economics and management	658	206	864	559	488	1067	585	387	972	586	443	1029	802	556	1358	5290
Law and Political Sciences	439	147	586	251	276	527	262	273	535	251	278	529	332	316	648	2825
Number of graduated students	6316	1246	7562	6139	2616	8755	4528	2975	7503	44315	3329	7644	6026	3036	9062	40526
Number of enrolled students	6948	1371	8319	6753	3878	10631	5058	3950	9008	4746	3658	8404	6650	3372	10022	46384

Source: Vice Rectorate of Higher Education at the Undergraduate and Graduate Level, Continuing Education and Diplomas, and Graduate Training of U-M

From the table (1) over the period 2014-2018 there are a continuous increase in the number of students. A total of 40526 students have completed a degree in higher education (licence + master) from its inception to 2019, while the total number enrolled students until 2018 was 46384 students distributed among faculties and Institutes of U-M. This is due to the democratization of access to university.

The democratization or “massification” is fostered by free access to higher education and the existence of university services in Algeria, such as dormitory, restaurants for students which have made it possible to benefit at a very low cost to higher education for the greatest number of students. This policy concerned all young students from all social categories, regions and localities of the country ( Zine et al, 2017). The expansion of higher education in Algeria led to increases in the funds allocated to U-M faculties and institutes as shown in the table(2).

**Table 2.** The evolution of the funds allocated to faculties and institutes at U-M in the period 2014-2019

Years	2014	2015	2016	2017	2018
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Faculties and institutes					
Mathematics and Computer sciences	37725000	36672800	27972225,41	29506991	255202476,39
Management of Urban Techniques	32915000	29620760	25516264,28	21441096	14172479,5
Sciences	62212620	65521560	48876149,36	48933890	48154015,35
Technology	45265000	36380080	35686898,97	33034344	34360062,16
Humanities and Social Sciences	50910000	46430080	36796269,04	33747370,9	38065098,94
Letters and Languages	51860000	48503560	30307161,54	34560307,4	33604403,29
Science and Technology of Physical and Sports Activities	45435000	33726480	21089077,62	23219918	20952032,38
Economics and management	52450000	44954800	34200560,85	36883154	32049137,32
Law and Political Sciences	40700000	35504268	29795119,82	29014928,7	24064959,85

Source: SUB-Directorate of Budget and Accounting of U-M, Units are in Algerian dinars.

From 2015 to 2019, table (3) employment among the graduated students of U-M generally increased slightly, interspersed with a decrease in the years 2014, 2016, and 2017. The unemployment number includes only those who are in age [24-34] years old. Due to the average age for obtaining the baccalaureate is 19 years, 3 or 4 years to obtaining licence, 2 years master, and the graduate student is employed in the following year.

**Table 3.** The evolution of employment among the graduated students of U-M in the period 2015-2019

Faculties and institutes	Years	2015	2016	2017	2018	2019	Σ
Mathematics and Computer sciences		60	51	55	60	67	<b>293</b>
Management of Urban Techniques		40	41	43	40	43	<b>207</b>
Science		185	160	158	205	208	<b>916</b>
Technology		160	170	173	173	175	<b>851</b>
Humanities and Social Sciences		1200	917	803	1150	1155	<b>5225</b>

Letters and Languages	1172	940	823	1100	1105	<b>5140</b>
Science and Technology of Physical and Sports Activities	35	38	36	35	37	<b>181</b>
Economics and management	610	581	766	610	615	<b>3182</b>
Law and Political Sciences	240	203	200	250	255	<b>1148</b>
<b>Number of graduated students employed</b>	<b>3702</b>	<b>3101</b>	<b>3057</b>	<b>3623</b>	<b>3660</b>	<b>17143</b>

*Source: Vice Rectorate of Higher Education at the Undergraduate and Graduate Level, Continuing Education and Diplomas, and Graduate Training of U-M*

#### **4.2 THE SOFTWARE FOR CALCULATING DEA EFFICIENCY AND EFFECTIVENESS VALUE**

This section presents and discusses the empirical results of the study. Using the performance evaluation model developed by (Cooper et al, 2000), (Ho and Zhu, 2004) and (Kumar et al, 2010), by taking the output variable from step I as an input variable in step II. To measure the efficiency and effectiveness of public spending on higher education in U-M faculties and institutes, the DEA is used to identify optimal function of DMUs and assigns their scores as mentioned by (Koser, 2019).

**In stage I:** The input used for computing the efficiency scores is funds allocated to faculties and institutes. The selected output variable is the number of students graduated.

**In stage II:** The input used for computing the effectiveness scores is the number of students graduated. The selected output variable is the number of employment among the graduated students in the next year.

**The overall performance scores** for U-M faculties and institutes have been computed by multiplying their respective efficiency and effectiveness.

The data from all DMU are subject to the calculation of the Frontier analyst software, the efficiency and effectiveness scores for U-M faculties and institutes that have been obtained by implementing output-oriented CCR model are given in table (4). If the DEA efficiency value is equal to 1, it means that it is a best efficiency and hence the unit is the most efficient, and the same way for effectiveness.

#### **4.3 THE EVALUATION RESULT AND FINDING OF U-M FACULTIES AND THEIR INSTITUTES**

Table (4) presents the CCR efficiency and effectiveness score and performance results, and provide a form of ranking for U-M faculties and institutes must from the best to worst. Efficiency scores range from 1 to 0.033, with average

0.489. Only Humanities and Social Sciences faculty in the year 2018 have been found to be efficient in the stage I, with efficiency score of one. ,And some degree of inefficiency has been observed, especially Mathematics and Computing faculty, sciences faculty, and Management of Urban Techniques institute .further it has been noted that estimated effectiveness scores range from 1 to 0.032 with average 0.349. Only Humanities and Social Sciences faculty in the year 2014 have been found to be effectiveness in the stage II, with effectiveness score of one. The overall performance score can be obtained by multiplying efficiency and effectiveness score for DMU with their ranks it has been noted that estimated performance scores range from 0.691 to 0.005.

The U-M faculties and institutes must have the potential to increase their outputs for improving theirs efficiency and effectiveness, and would be able to improve their performance either by improving their efficiency or effectiveness or both according to table (5).

**Table 4.** Evaluation results of public spending performance in U-M faculties and institutes

No	DMU	Efficiency Score	Ran k	Effectiveness Score	Ran k	Performance Score	Ran k
1	T2014 DMU Mathematics and Computer sciences	0,294	37	0,110	38	0,032	38
2	T2014 DMU Management of Urban Techniques	0,316	34	0,078	40	0,025	41
3	T2014 DMU sciences	0,225	42	0,268	24	0,060	30
4	T2014 DMU technology	0,262	40	0,274	23	0,072	27
5	T2014 DMU Humanities and Social Sciences	0,478	21	1,000	1	0,478	6
6	T2014 DMU Letters and Languages	0,642	11	0,714	5	0,458	7
7	T2014 DMU STPSA	0,367	25	0,043	44	0,016	43
8	T2014 DMU Economics and management	0,328	30	0,720	4	0,236	15
9	T2014 DMU Law and Political Sciences	0,286	38	0,417	17	0,119	19
10	T2015 DMU Mathematics and Computer sciences	0,317	33	0,089	39	0,028	40
11	T2015 DMU Management of Urban Techniques	0,220	43	0,128	35	0,028	40
12	T2015 DMU sciences	0,261	41	0,189	27	0,049	31
13	T2015 DMU technology	0,320	31	0,296	21	0,095	24
14	T2015 DMU Humanities and Social Sciences	0,655	10	0,611	9	0,400	10
15	T2015 DMU Letters and Languages	0,846	6	0,465	15	0,393	11
16	T2015 DMU STPSA	0,715	9	0,032	45	0,023	42
17	T2015 DMU Economics and management	0,472	22	0,555	13	0,262	14
18	T2015 DMU Law and Political Sciences	0,295	36	0,393	19	0,116	20

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19	T2016 DMU Mathematics and Computer sciences	0,318	32	0,125	36	0,040	33
20	T2016 DMU Management of Urban Techniques	0,213	44	0,161	30	0,034	37
21	T2016 DMU sciences	0,433	24	0,151	32	0,065	28
22	T2016 DMU technology	0,356	28	0,276	22	0,098	23
23	T2016 DMU Humanities and Social Sciences	0,790	8	0,561	12	0,443	9
24	T2016 DMU Letters and Languages	0,972	3	0,566	11	0,550	5
25	T2016 DMU STPSA	0,596	12	0,058	42	0,035	36
26	T2016 DMU Economics and management	0,566	13	0,803	3	0,454	8

No	DMU	Efficiency Score	Ran k	Effectiveness Score	Ran k	Performance Score	Ran k
27	T2016 DMU Law and Political Sciences	0,357	27	0,381	20	0,136	18
28	T2017 DMU Mathematics and Computer sciences	0,314	35	0,131	34	0,041	32
29	T2017 DMU Management of Urban Techniques	0,269	39	0,141	33	0,038	34
30	T2017 DMU sciences	0,347	29	0,245	25	0,085	26
31	T2017 DMU technology	0,452	23	0,235	26	0,106	21
32	T2017 DMU Humanities and Social Sciences	0,847	5	0,816	2	0,691	1
33	T2017 DMU Letters and Languages	0,945	4	0,683	6	0,645	3
34	T2017 DMU STPSA	0,555	14	0,055	43	0,031	39
35	T2017 DMU Economics and management	0,555	15	0,604	10	0,335	13
36	T2017 DMU Law and Political Sciences	0,363	26	0,482	14	0,175	17
37	T2018 DMU Mathematics and Computer sciences	0,033	45	0,160	31	0,005	44
38	T2018 DMU Management of Urban Techniques	0,532	18	0,116	37	0,062	29
39	T2018 DMU sciences	0,493	19	0,178	29	0,088	25
40	T2018 DMU technology	0,552	16	0,187	28	0,103	22
41	T2018 DMU Humanities and Social Sciences	1,000	1	0,615	8	0,615	4
42	T2018 DMU Letters and Languages	0,994	2	0,671	7	0,667	2
43	T2018 DMU STPSA	0,486	20	0,074	41	0,036	35
44	T2018 DMU Economics and management	0,843	7	0,462	16	0,389	12
45	T2018 DMU Law and Political Sciences	0,536	17	0,401	18	0,215	16

Descriptive statistic					
Average	0,489		0,349		0,202
SD	0,237		0,252		0,680
Maximum	1,000		1,000		0,691
Minimum	0,033		0,032		0,005

Source: Author’s calculations using DEA software.

Note: performance Score= efficiency score × effectiveness score

Table (5) illustrate the correlation coefficient between efficiency, effectiveness, and performance scores draw a more accurate inference about the relationship among these measures scores. There is a positive and statistically significant correlation between efficiency and effectiveness, this means that high efficiency lead to high effectiveness education in U-M faculties and institutes.

Further, a positive significant and strong correlation exists relates to both efficiency and effectiveness measures with public spending performance on higher education at the U-M faculties and institutes.

**Table 5.** Pearson’s correlation coefficients of efficiency, effectiveness, and performance scores

	Efficiency	Effectiveness	Performance
Efficiency	1	,517**	,815**
Effectiveness	,517**	1	,881**
Performance	,815**	,881**	1

\*\* Correlation coefficient is significant at the 0.01 (two-tailed)

Source: Author’s calculations using SPSS output

#### 4.4. PROCESS IMPROVEMENT

The analysis of the previous section indicates which U-M faculties and institutes were efficient and which were inefficient. For each stage, insufficient U-M faculties and institutes are able to improve their public spending performance via stage I or stage II, by either increasing its efficiency or effectiveness or both.

To achieve full efficiency and effectiveness in an output-oriented model, the U-M faculties and institutes inefficient DMU may focus on an increase in its outputs –this would imply an increase in the number of students graduated for efficiency, and an improvement in the number of employment among the graduated students (employment rate) for effectiveness, while the inputs proportions remain the same.

The analysis in the empirical study indicates which faculties and institutes in the U-M were effective and which were ineffective. And for each step, insufficient the U-M faculties and institutes are able to improve their public

expenditure performance through phase I or phase II, increasing their efficiency or effectiveness or both.

To achieve maximum efficiency and effectiveness in a results-oriented model, ineffective UM faculties and institutes DMU can focus on increasing their results - this would imply an increase in the number of graduate students for effectiveness, and improving the number of employment among graduate students (employment rate) for efficiency, while the input proportions remain the same.

## 5. CONCLUSION AND RECOMMENDATIONS

This study focus in measuring the performance of public spending on higher education at the University of M'sila, in terms of efficiency and effectiveness using DEA, as well as, to provide suggestions for further improvement those be founded.

a: The data show that Over the period 2014-2018 there are a continuous increase in the number of students enrolled which led to increases in the funds allocated to U-M faculties and institutes. This is due to the free access to Universities.

b: The performance evaluation model developed by (Cooper et al, 2000), (Ho and Zhu, 2004), and (Kumar et al, 2010) is used in evaluation, hens the output variable of Stage I as the input variable in the Stage II, DEA is used to measure the efficiency and effectiveness of public spending on higher education at the U-M faculties and institutes.

c: By using the model of (Koser, 2019), DEA identifies optimally performing DMUs and assigns their scores.

d: The founded results shows the efficiency and effectiveness score and performance results, and provide a form of ranking for the U-M faculties and institutes from the best to worst.

e: Efficiency scores range from 1 to 0.033, with average 0.489. only Humanities and Social Sciences faculty in the year 2018 have been found to be efficient in the stage I. Further it has been noted that estimated effectiveness scores range from 1 to 0.032 with average 0.349. Only Humanities and Social Sciences Faculty in the year 2014 have been found to be effectiveness in the stage II.

f: Performance scores estimated range from 0.691 to 0.005. U-M faculties and institutes should have the potential to increase their outputs to improve theirs efficiency and effectiveness, and would be able to improve their performance either by improving their efficiency or effectiveness or both. To achieve full efficiency and effectiveness in an output-oriented model, the U-M faculties and institutes inefficient DMU may focus on an increase in its outputs, this would imply an increase in the number of students graduated for efficiency, and an improvement in the number of employment among the graduated students (employment rate) for effectiveness.

The findings of this study would help the staff of the university to develop appropriate policies and guide the managers in making strategic actions for improving the performance of public expending in faculties and institutes of the University of M'sila.

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