

Measuring Efficiency of Qatari Public Secondary Boys Schools outside Doha

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Abstract

This project studies the efficiency of public secondary schools in Qatar. The first formal school in Doha was established in 1949. Since then, there are approximately 338 schools in the 8 municipalities in Qatar directed and controlled by the Supreme Education Council (SEC) and the Ministry of Education (MOE). The 8 municipalities in Qatar are subdivided into 98 zones. However, in this case, we are focusing on Public Secondary boys schools from 46 of the 98 zones which are outside Doha.

In Qatar, PISA administration is census-based. This means that all eligible 15 year old students in Private Arabic, independent, community and international schools. The PISA assess if students completing the level of compulsory schooling are prepared to meet the challenges of today's societies. The PISA tests three domain specific areas such as Reading, Mathematics and Scientific literacy. To determine the efficiency, the two outputs used are the average test scores for math and science in PISA taken by Grade 10 students in the year 2016. The inputs included are the number of students per teacher, the number of students per classroom and the average hours spent by teachers.

We then used Data Envelopment Analysis (DEA) to measure their efficiency using these inputs of the PISA score in Mathematics and Science, the average training hours per teacher, the teacher to student ratio and the classroom to student ratio.

Background

Our data was obtained from the Ministry of Education and Higher Education. It provides a list of schools in Qatar along with the average PISA scores of the students in each of the schools. We specifically looked at the schools that were located outside Qatar. Our data includes the average number of annual training hours per teacher, the number of teachers per student and the number of classroom per students. These were the inputs and outputs that was used to estimate the efficiency.

| School | PISA Mathematics | PISA Science | Avg. Annual Training Hours per Teacher | # of Teachers / Students | # of Classrooms / Students |
|--|------------------|--------------|--|--------------------------|----------------------------|
| Naser Bin Abdulla Secondary School | 308 | 328 | 28 | 10 | 24 |
| Mohammad Bin Abdulwahhab Secondary School | 306 | 322 | 40 | 10 | 28 |
| Ahmed Bin Mohammad Secondary School | 380 | 383 | 39 | 10 | 19 |
| Abdullah Bin Ali AlMinsad Secondary School | 351 | 348 | 39 | 11 | 24 |
| Ali Bin Jassim Bin Mohammed Al Thani Secondary | 386 | 412 | 40 | 8 | 19 |
| Al Jumailiya Secondary School | 282 | 308 | 47 | 5 | 16 |
| Al Karaana Secondary School | 329 | 339 | 51 | 5 | 14 |
| Al Shamal Secondary School | 342 | 350 | 41 | 7 | 13 |
| Al Wakra Secondary School | 357 | 364 | 37 | 12 | 27 |
| Al Zubara Secondary School | 369 | 378 | 35 | 6 | 15 |
| Ashahaniya Secondary School | 324 | 352 | 36 | 9 | 24 |
| Al Saaliya Secondary School | 346 | 376 | 69 | 8 | 20 |
| Doha Secondary School | 365 | 379 | 36 | 9 | 23 |
| Hamad Bin Abdulla Bin Jassem Secondary School | 333 | 355 | 48 | 9 | 21 |
| Ibn Taymiyyah Secondary School | 315 | 326 | 59 | 10 | 27 |
| Mohammad Bin Abdulaziz AlMans Secondary School | 318 | 332 | 36 | 12 | 27 |
| Rawdat Rashid Secondary School | 280 | 305 | 35 | 7 | 18 |

Methodology

Using Data Envelopment Analysis, we created a linear programming model to find the efficiency of each of the 17 schools outside of Doha. This technique allows us to compare the efficiency of multiple service units (i.e., schools) that provide similar services by explicitly considering their use of multiple inputs (i.e., resources such as teacher training hours) to produce multiple outputs (i.e., PISA test results). This approach is much more effective than solely relying on ratios as DEA considers both the mix of outputs and inputs explicitly in the linear programming model. Although we solved 17 different linear programming models, the following is the general definition approach of the models for a given school e :

Maximize

$$u_1 * O_{1e} + u_2 * O_{2e}$$

Subject to

$$u_1 * O_{1k} + u_2 * O_{2k} - (v_1 * I_{1k} + v_2 * I_{2k} + v_3 * I_{3k}) \leq 0 \quad k = 1, 2, \dots, 17$$

$$u_1, u_2 \geq 0$$

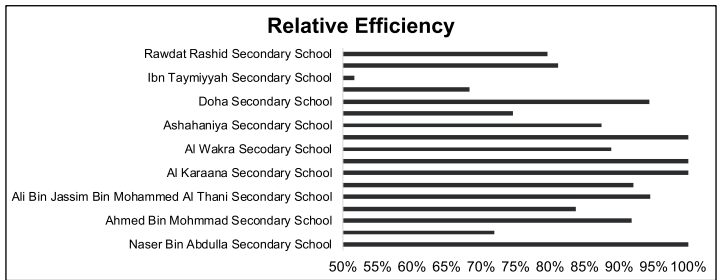
$$v_1, v_2 \geq 0$$

In the above model, we consider O_1 and O_2 to be the output values of the PISA Mathematics score and the PISA Science score respectively. The weight variables to each of these output quantities are u_1 and u_2 respectively. The input variables I_1 , I_2 , and I_3 account for input resources which are the average number of training hours per teacher, the number of teachers per student, and the number of classrooms per student. The weight variables to each of these input quantities are v_1 , v_2 , and v_3 respectively. The following is a screenshot of a sample model formulation on Microsoft Excel:

| Variables: | Outputs | | Inputs | | | | | |
|---|------------------|--------------|--|--------------------------|----------------------------|---|---------|------|
| | PISA Mathematics | PISA Science | Avg. Annual Training Hours per Teacher | # of Teachers / Students | # of Classrooms / Students | | | |
| Values: | 0 | 0.002429558 | 0.023992212 | 0 | 0.00517751 | | | |
| Objective: | 386 | 412 | 37.58 | 8 | 19 | = | 0.9999 | |
| Constraints: | | | | | | | | |
| 1 Naser Bin Abdulla Secondary School | 308 | 328 | -28 | -10 | -24 | = | 0 | <= 0 |
| 2 Mohammad Bin Abdulwahhab Secondary School | 306 | 322 | -40 | -10 | -28 | = | -0.3222 | <= 0 |
| 3 Ahmed Bin Mohammad Secondary School | 380 | 383 | -39 | -10 | -19 | = | -0.1045 | <= 0 |
| 4 Abdullah Bin Ali AlMinsad Secondary School | 351 | 348 | -39 | -11 | -24 | = | -0.2154 | <= 0 |
| 5 Ali Bin Jassim Bin Mohammed Al Thani Secondary School | 386 | 412 | -40 | -8 | -19 | = | -0.0502 | <= 0 |
| 6 Al Jumailiya Secondary School | 282 | 308 | -47 | -5 | -16 | = | -0.463 | <= 0 |
| 7 Al Karaana Secondary School | 329 | 339 | -51 | -5 | -14 | = | -0.4733 | <= 0 |
| 8 Al Shamal Secondary School | 342 | 350 | -41 | -7 | -13 | = | -0.2016 | <= 0 |
| 9 Al Zubara Secondary School | 369 | 378 | -35 | -6 | -15 | = | -0.1441 | <= 0 |
| 10 Ashahaniya Secondary School | 324 | 352 | -36 | -9 | -24 | = | -0.1337 | <= 0 |
| 11 Al Saaliya Secondary School | 346 | 376 | -69 | -8 | -20 | = | -0.9465 | <= 0 |
| 12 Doha Secondary School | 365 | 379 | -36 | -9 | -23 | = | -0.063 | <= 0 |
| 13 Hamad Bin Abdulla Bin Jassem Secondary School | 333 | 355 | -48 | -9 | -21 | = | -0.3989 | <= 0 |
| 14 Ibn Taymiyyah Secondary School | 315 | 326 | -59 | -10 | -27 | = | -0.7641 | <= 0 |
| 15 Mohammad Bin Abdulaziz AlMans Secondary School | 318 | 332 | -36 | -12 | -27 | = | -0.1978 | <= 0 |
| 16 Rawdat Rashid Secondary School | 280 | 305 | -35 | -7 | -18 | = | -0.1927 | <= 0 |
| Inputs | 1 | 0 | 0 | 0 | 0 | = | 1 | <= 1 |
| Non-negative | 0 | 0 | 0 | 0 | 0 | = | 0 | >= 0 |
| | 0 | 0 | 0 | 0 | 0 | = | 0.0024 | >= 0 |
| | 0 | 0 | 0 | 0 | 0 | = | 0 | >= 0 |
| | 0 | 0 | 0 | 0 | 0 | = | 0.0052 | >= 0 |

Results

We found that overall, there are a number of relatively inefficient schools outside of the municipality of Doha and we studied them in depth to identify reasons behind their lack. In particular, we found that the lowest performing school in terms of relative efficiency was Ibn Taymiyyah Secondary School with a relative efficiency of just 51.69%. When digging deeper to analyze its bottleneck, we identified that Ibn Taymiyyah Secondary School stands to gain the most from increasing the number of teachers per student. In particular, our model indicates that the school can increase its output in terms of PISA Mathematics and PISA Science scores by approximately 8.97% for every additional teacher. Moreover, we also found that the school stands to gain less in terms of increasing the number of average annual training hours per teacher as the results indicate it can only increase output levels by 0.0017% for every hour increase. Therefore, we recommend to Ibn Taymiyyah Secondary School to increase the number of teachers to achieve higher scores in PISA examinations.



Conclusion

By using Data Envelopment Analysis (DEA), we were able to measure the productivity or efficiency of the Public schools with the data of the outputs, the PISA scores and the inputs, average annual training hours for the teachers, the average number of teacher per student and the number of classroom per student. DEA can further be used by corporate management to evaluate the productivity of fast-food outlets, health clinics, police stations, banks and other service departments. This DEA model can identify relatively inefficient units, measure the magnitude of inefficiencies and discover ways to reduce the inefficiencies, as it attempts to maximize a service unit's efficiency expressed as the ratio of outputs to inputs and compares a particular unit's efficiency with the performance of the similar group of service units.

DEA can be used for strategy panning by companies. The table on the right explains the different categories of a company's efficiency in relation to profit. Companies with the least efficiency and with low profit represents that the branches are not on the efficient frontier. Companies with high efficiency but low profit would need to reduce an asset and obtain capital.

| | | | |
|--------|------|----------------------------------|----------------------------|
| Profit | High | Under-performing potential stars | Benchmark group |
| | Low | Problem Branches | Candidates for divestiture |
| | | Low | High |
| | | Efficiency | |

However, a limitation of using DEA is that it only provides relative efficiencies from the data considered. It does not provide absolute efficiencies. Nevertheless, DEA aids companies in learning about their current position and strategizing to reach or become a benchmark group with high profit and high efficiency.

Future Extensions

In terms of future extensions, there are two key areas that we suggest future research to expand. Firstly, there is the output variables and the possibility of increasing their reach. We recommend that future research includes additional output variables such as national test scores rather than solely international examinations. We also recommend adding the percentage of students that pass secondary school and go into university education. Secondly, we also recommend investigating the input variables for future research. Additional input variables could include the average number of years of experience of teachers and their highest education level to capture an approximate quantification of quality of teachers. Another additional input could be the quantity and quality of technological facilities at schools such as computer labs, science labs, etc. Moreover, future studies can also investigate psychological implications on students such as the percentage of students that feel safe, that have been bullied, etc. to consider as an input an approximate of students' mental health.

Ministry of education and higher education - Schools list. Retrieved from <https://www.edu.gov.qa/En/ServicesCenter/Pages/QatariSchoolsListing.aspx>



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