

**VIRGINIA COMMONWEALTH UNIVERSITY**

**PRESCRIPTIVE ANALYSIS**

**ASSIGNMENT 5**

**SATYANARAYAN VENKAT NALDIGA**

**V01108247**

**SUBMITTED TO-**

**PROF.PAUL BROOKS**

**Date of Submission: 12-12-2024**

**PROBLEM**

The problem involves evaluating hospital efficiency based on resource utilization (inputs like beds and physicians) and outcomes (outputs like surgery success rates, profit, and patient satisfaction). Using **Data Envelopment Analysis (DEA**), the goal is to identify efficient hospitals by maximizing their outputs relative to inputs. DEA solves an optimization model for each hospital, determining optimal weights for inputs and outputs while ensuring no hospital's weighted outputs exceed its weighted inputs. This analysis highlights efficient hospitals on the efficiency frontier and identifies underperforming ones, offering insights for administrators to optimize resource utilization and improve performance.

**Data Definition**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Hospital | Input 1 | Input 2 | Input 3 | Output 1 | Output 2 | Output 3 | Output 4 | Output 5 | Output 6 | Output 7 |
| 1 | 83.7033 | 2.994 | 8.048 | 51.1574 | 32.7153 | 66.2448 | 35.7387 | 49.023 | 49.2987 | 39.5518 |
| 2 | 91.5586 | 1.1948 | 77.4837 | 9.8605 | 70.3838 | 127.5586 | 59.4214 | 88.7819 | 46.5052 | 2.3613 |
| 3 | 43.7093 | 0.8526 | 185.2281 | 8.741 | 31.4517 | 2.281 | 31.1873 | 30.2933 | 18.9924 | 11.3759 |
| 4 | 79.9493 | 1.1131 | 63.5319 | 19.5161 | 0.5712 | 82.8274 | 105.6284 | 17.5802 | 33.5798 | 10.0547 |

**\*\*REST DATA IN EXCEL**

**Objective in Words:**

**Decide**

the efficiency of hospitals

**so that** the ratio of their weighted outputs (e.g., surgery success rate, profit, patient satisfaction) to their weighted inputs (e.g., number of beds, number of physicians) is maximized,

**subject to the following constraints**:

* The weighted sum of outputs for each hospital must not exceed the weighted sum of inputs, ensuring a consistent and fair efficiency evaluation.
* The inputs and outputs of the hospital being evaluated are scaled to normalize its efficiency score.
* The weights assigned to inputs and outputs are non-negative, allowing the model to determine the most favorable combination for efficiency maximization.

**Decision Variables:**  
Let:

**Algebraic Formulation:**

**Maximize** the weighted sum of outputs for the hospital being evaluated:

***Subject to****:*

**Efficiency Constraint** For all hospitals , the weighted sum of outputs must not exceed the weighted sum of inputs:

**Normalization Constraint**: The weighted sum of inputs for the hospital being evaluated is normalized to 1:

**Non-negativity Constraints**:

# Implementation:

An implementation and solution of the model using Python, and AMPL is available below,

[**https://drive.google.com/drive/folders/1IhHBLiBIrOn9YMhGsexMD9DzEceqJUFl?usp=sharing**](https://drive.google.com/drive/folders/1IhHBLiBIrOn9YMhGsexMD9DzEceqJUFl?usp=sharing)

[**https://colab.research.google.com/drive/1iH3AC7i6z5z3zcDL3V\_BCKNgn\_aiqkuI?usp=sharing**](https://colab.research.google.com/drive/1iH3AC7i6z5z3zcDL3V_BCKNgn_aiqkuI?usp=sharing)

**Results**

* 9 1.000000
* 11 1.000000
* 12 1.000000
* 14 1.000000
* 42 1.000000
* 45 1.000000
* 47 1.000000
* 50 1.000000
* 51 1.000000
* 60 1.000000
* 80 1.000000
* 82 1.000000
* 83 1.000000
* 85 1.000000
* 95 1.000000
* 99 1.000000
* 106 1.000000
* 108 1.000000
* 114 1.000000
* 151 1.000000
* 167 1.000000
* 168 1.000000
* 178 1.000000
* 189 1.000000
* 193 1.000000
* 203 1.000000
* 209 1.000000
* 213 1.000000
* 223 1.000000
* 225 1.000000
* 231 1.000000
* 252 1.000000
* 256 1.000000
* 259 1.000000
* 279 1.000000
* 282 1.000000
* 284 1.000000
* 288 1.000000
* 291 1.000000
* 296 1.000000
* 297 1.000000
* 303 1.000000
* 306 1.000000
* 308 1.000000
* 319 1.000000
* 329 1.000000
* 334 1.000000
* 339 1.000000
* 344 1.000000
* 345 1.000000
* **Total number of efficient hospitals: 50**

Data Envelopment Analysis (DEA) revealed that **50 hospitals** operate on the efficiency frontier, achieving a perfect score of **1.000000**. These hospitals are maximizing their performance, producing the greatest possible outputs (e.g., surgery success rates, profit, patient satisfaction) for a given level of inputs (e.g., number of beds and physicians). By analyzing these efficient peers, less efficient hospitals can identify opportunities to improve their operations, such as optimizing resource allocation or enhancing outcome measures.