

Relative Efficiency of Engineering Programs at a Brazilian Federal University: A DEA-BCC Approach with Two-Dimensional Representation

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Abstract

Assessing efficiency in higher education institutions has become a growing concern in the academic literature, especially for public universities balancing multiple objectives with limited resources. This study examines the relative efficiency of undergraduate Engineering programs at the Universidade Federal Rural do Semi-Árido (UFERSA), a Brazilian federal university, over the period from 2020 to 2025. Data Envelopment Analysis (DEA) was applied using the output-oriented BCC model, which accounts for variable returns to scale among programs of different sizes. Thirteen Decision-Making Units (DMUs) were defined as individual undergraduate Engineering programs, using faculty size and number of enrolled students as inputs, and number of graduates and the Preliminary Course Concept (CPC), the official Brazilian quality indicator issued by the National Institute for Educational Studies and Research (INEP), as outputs. Data were collected from publicly available institutional sources. The DEA model was implemented in R using the Benchmarking package. Nine of the thirteen DMUs reached a radial efficiency score of 1, but slack analysis revealed that only five are strongly efficient. The remaining four on the efficiency frontier were classified as weakly efficient due to positive input slacks, and four programs were found to be inefficient, with standardized scores between 0.75 and 0.97. Among the programs analyzed, two undergraduate Industrial Engineering programs exhibited contrasting profiles: one was weakly efficient due to significant input slacks, while the other was inefficient, requiring output expansion and regulatory quality improvement. These findings suggest that Industrial Engineering programs can benefit from process-oriented management approaches to enhance academic resource conversion. The results offer quantitative information to guide benchmarking, institutional diagnosis, and continuous improvement in Engineering program management.

Keywords

Engineering Education, Data Analysis, Academic Performance, Higher Education.

Biography

Rafael de Azevedo Palhares is a doctoral candidate in Production Engineering at the Federal University of São Carlos (UFSCar), Brazil. He previously served as a faculty member in the Production Engineering undergraduate program at the Universidade Federal Rural do Semi-Árido (UFERSA), Campus Angicos, where he taught courses in Probabilistic Modeling and Production Systems Simulation, Operations Research II, Fundamentals of Production Engineering, and Integrated Production Systems Design. He holds an M.Sc. in Production Engineering from the Federal University of Rio Grande do Norte (UFRN) and a B.Sc. in Production Engineering from UFERSA. He is the developer of the Weighted Fuzzy Reference Ideal Method (W-FRIM), a multicriteria decision-making method published in the journal Expert Systems with Applications.