Evaluating a multiple quality characteristic process using data envelopment analysis

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Taguchi methods provide a comprehensive methodology for quality improvement. The objective is based on a robust design and involves conducting experiments using orthogonal arrays and the estimation factor levels combination that optimizes a given performance measure, typically a Signal-to-Noise ratio. The problem is more complex in the case of multiple responses since the combinations of factor levels that optimise the different responses usually differ.

In this paper, a three-step approach to find the optimal parameter combination in robust design is presented. Starting the results of the experiments, their Mean Square Deviations (MSD) are used to train a Neural Network which afterwards can be used to estimate the MSD of those factor combinations for which no experimental data exist. Once MSD of all quality characteristics for all factor combinations are available, a units-invariant, non-radial, pure-input, Variable Returns to Scale -Data Envelopment Analysis (DEA) model is proposed to assess their relative efficiency. Finally, a second DEA model is used to choose among the efficient factor combinations the one that allows a higher overall penalization of the Quality Loss associated to the different characteristics. The proposed approach is applied to a number of case studies taken from the literature and compared with existing approaches.