

Accepted Manuscript

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PII: S0959-6526(17)32158-3

DOI: [10.1016/j.jclepro.2017.09.160](https://doi.org/10.1016/j.jclepro.2017.09.160)

Reference: JCLP 10665

To appear in: *Journal of Cleaner Production*

Received Date: 21 November 2016

Revised Date: 4 September 2017

Accepted Date: 15 September 2017

Please cite this article as: Zhou X, Xu Z, Yao L, Tu Y, Lev B, Pedrycz W, A novel Data Envelopment Analysis model for evaluating industrial production and environmental management system, *Journal of Cleaner Production* (2017), doi: 10.1016/j.jclepro.2017.09.160.

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A Novel Data Envelopment Analysis Model for Evaluating Industrial Production and Environmental Management System

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Abstract

Industrial production and environmental management systems should be simultaneously considered for sustainable development. This paper evaluated the performance of an integrated two-stage system using a proposed type-2 fuzzy bi-objective two-stage slacks-based measurement Data Envelopment Analysis model with super efficiency. A Step Method was applied to solve for the Pareto optimal solution to ensure no implicit priority was given to one stage over the other, and a CV-based reduction method and generalized credibility based chance constrained programming were used to cope with the type-2 fuzzy variables. A case study in China was then developed from a time-perspective and a region-perspective, the results from which indicated that the overall performance of China's integrated system improved from 2005 to 2014, and the efficiency gap between the industrial production system and the environmental management system reduced, however, there was significant disparity shown across the different economic regions. Three comparative analyses were then conducted to highlight the superiority of the proposed model. The developed model was able to: measure efficiency scores and find proportionate ratios and disproportionate slacks for each DMU to decrease inputs for performance improvement, distinguish the DMU from DMUs with same efficiency value and indicate the maximum change scope for the inputs and outputs to maintain the DMU efficiency. In addition, type-2 fuzzy sets were incorporated to describe the fuzziness with greater flexibility, which can assist decision makers and produce more accurate, robust results.

Keywords: DEA, Economic efficiency and environmental efficiency, Industrial production and environmental management system, Overall efficiency

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