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Reprint of "Planning in feasible region by two-stage target-setting DEA methods: An application in green supply chain management of public transportation service providers" ☆

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ABSTRACT

To meet green supply chain management's requirements of a company and its transportation service providers (TSPs), it is essential to set clear, achievable, and realistic targets. This paper proposes two data envelopment analysis (DEA) approaches to find targets for two-stage network structures. The objective of proposed approaches is to plan in feasible region. The feasible region specifies bounds to ensure targets are within current operational capacity of TSPs. Applying the approaches to set targets for 24 TSPs lead to different results. However, proposed models ensure that the TSPs would be efficient in their current capacity.

1. Introduction

Green supply chain management (GSCM) has emerged as a key approach for organizations seeking to become environmentally sustainable (Shabani et al., 2014; Yang et al., 2013; HooBae et al., 2011). One of the key elements in success of GSCM is transportation. Though the value of green transportation activities for GSCM is rarely discussed, Supply Chain and Logistics Association of Canada (SCL) provided tangible evidence on performance of GSCM. The report reveals that companies that have adopted green logistic, their GSCM's performance have been improved.[1] Different findings of the report illustrate that how green transportation affect the performance of GSCM. Firstly, the most best-in-class (BIC) firms can increase distribution efficiency and service differentiation through green transportation practices while reducing distribution cost. Secondly, high cost of energy is driver for implementing green transportation practices in distribution activities. Thirdly, a large

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[1] For details see www.ic.gc.ca/logistics.

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portion of BIC firms increased their use of multi-modal transportation to maximize environmental and business benefits. Finally, most transportation service providers (TSPs) that implement green transportation have reduced energy and waste in their distribution activities. In addition, Olugu et al. (2011) showed how green transportation affects firm's performance.

In GSCM, companies try to collaborate with each other to achieve more product innovation, less expenditures, less risk, and higher quality. Targets play a key role in this issue. Targets generally establish a sense of direction that guides operations and decisions of an organization whose targets are commonly aligned with their mission. As a result, setting business targets provides an organization with a structured framework. Target setting enables organizations to understand whether they perform successfully or not. Well-defined targets provide a detailed guideline to everyone involved within the organization. Setting targets for a network structure is important since individuals, departments, and organizations set them to have forward-looking in their activities (Lin, 2011; Kazemi Matin et al., 2014). Setting realistic and achievable targets helps an organization in several ways including augmentation of workforce motivation, performance evaluation, and financial success (Hosseinzadeh Lotfi et al., 2013).

To have an accurate planning in transportation sector, performance monitoring, assessment, and reporting are popular activities. To perform these tasks, data envelopment analysis (DEA) is an appropriate tool. DEA can be used as a planning tool since it estimates expected cost and profit efficiency. DEA can be used as a performance monitoring tool through comparison and analysis of different cases in different periods of time. It is also a performance reporting tool because it may produce very meaningful results. Finally, DEA is a performance assessment tool since it estimates relative efficiency of a set of decision making units (DMUs). DMUs are entities which consume multiple inputs to produce multiple outputs (Farzipoor Saen, 2009; Azadi and Farzipoor Saen, 2012). One of the significant uses of DEA is to set targets for inefficient DMUs. Although target-setting is important for success of every system, identification of sensible and attainable targets is more important. In this paper, we develop approaches to identify such targets for DMUs.

To increase efficiency of a DMU through optimizing inputs/outputs quantities, there are five general strategies: (*i*) increasing outputs, while maintaining the same level of inputs, (*ii*) maintaining outputs, while reducing the level of inputs, (*iii*) increasing outputs and reducing inputs, simultaneously, (*iv*) increasing both inputs and outputs, but enlarging outputs by more than proportional change in inputs, and (*v*) decreasing both inputs and outputs, but reducing outputs by less than proportional change in inputs. In Fig. 1, these five strategies correspond to line segment AC, line segment AB, zone 1, zone 2, and zone 3, respectively. Given these strategies, following properties are defined as important features of a DEA-based target-setting model:

(*P*1) *Capability to plan in feasible region:* feasible planning region specifies targets' bounds which are within current operational capacity of DMUs. Thus, a DMU does not need to increase its resources (inputs) to increase its productions (outputs). It means targets will be achievable and practical. In Fig. 1, this region is resulted from aggregation of line segments AB and AC, and zone 1.

(*P*2) *Ability to identify efficient targets:* the model should recognize targets in which a DMU becomes efficient. In other words, the DMUs should be projected onto efficiency frontier after achieving specified input/output targets.

(*P*3) *Generality:* the model should be extendable for DMUs with internal networks. The DMUs can have network structures where some of outputs of a stage are inputs of next stage. Such factors among multiple stages are called intermediate outputs/inputs (Chen et al., 2009).

(*P*4) *Considering viewpoints of decision makers:* the model should consider managerial ideas to set targets for DMUs.

The proposed approaches of this paper are based upon two ideas. First, we follow the approach introduced originally by Stewart (2010). However, this approach satisfies only in *P*2. In Stewart (2010), determined targets for inputs may be greater than current levels while they should be smaller than or equal to current amounts. Also, the outputs' targets should be at

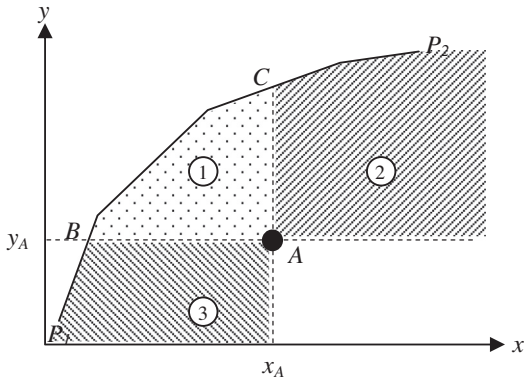

Fig. 1. Different strategies for improving efficiency.