



# Green supplier development program selection using NGT and VIKOR under fuzzy environment <sup>☆</sup>



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## ABSTRACT

Developing environmental performance of suppliers is critical for green supply chain management. Organizations are nowadays investing in various green supplier development programs to enhance their supplier performances. The decision to select the right program for green supplier development is often a challenging decision due to lack of prior experience, limited quantitative information, specific context of the organization, and varying supplier backgrounds. This paper addresses the problem of evaluating green supplier development programs and proposes a fuzzy NGT (Nominal Group Technique)-VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje) based solution approach. NGT is used to identify criteria for evaluating green supplier development programs. Fuzzy theory is used to address qualitative (linguistic) ratings for the alternatives and the selected criteria used under lack of quantitative information. VIKOR is used to generate green supplier development program rankings and recommend the best program(s) for implementation. Sensitivity analysis is performed to determine the influence of modeling parameters on ranking results of alternatives. A numerical application is provided.

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## 1. Introduction

Improving the environmental performance of suppliers is critical in developing green supply chains. Suppliers being the first and the foremost critical link in any organization exercise a great control in developing green supply chain performance by furnishing essential raw materials. More and more organizations are investing in various green initiatives such as green purchasing (Min & Galle, 2001; Tate, Ellram, & Dooley, 2012), design for environment, reverse logistics, ISO 14001 certification (Chen, 2005; Chiarini, 2013) to enhance their business performance and competitiveness. Several studies now confirm that organizations involved in greening the suppliers, green operations, and green innovation rank superior on environmental performance and competitive advantage (Caniëls, Gehrsitz, & Semeijn, 2013; Chiou, Chan, Lettice, & Chung, 2011; Figge & Hahn, 2012; Lo, Yeung, & Cheng, 2012; Rao & Holt, 2005; Wong, Lai, Shang, Lu, & Leung, 2012; Yang, Lin, Chan, & Sheu, 2010). Therefore, it is critical to investigate solution

approaches that enhance environmental performance of suppliers for greening the supply chains.

Environmental performance evaluation of suppliers is the first step in green supplier development. Suppliers who rank low on environmental performance could be assisted through various green supplier development programs such as ISO 14000 certification, supplier training, resource sharing, supplier rewards, capacity building. Bai and Sarkis (2010a,b) classify green supplier development programs into three categories: green knowledge transfer and communication, investment and resource transfer, and management and organizational practices. The green knowledge and transfer communication programs include supplier training on environmental issues, providing advice on environmental considerations, information sharing on environmental topics, etc. The investment and resource transfer programs include activities such as transferring employees with environmental expertise among buyer–supplier firms, supplier rewards, and investment in supplier capacity building. The management and organizational practices involve developing a formal process of supplier development, mandatory ISO 14000 certification, building top management commitment, etc. Table 1 presents the commonly used approaches in green supplier performance evaluation and development.

It can be seen in Table 1 that majority of the supplier environmental performance evaluation and development approaches used are multicriteria in nature. Bai and Sarkis (2010b) introduced a

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**Table 1**  
Approaches for green supplier performance evaluation and development.

Method	Method	Author(s)	Decision	
Multicriteria decision making	AHP	Chiouy, Chou, and Yeh (2011)	Sustainable supplier selection	
		Dai and Blackhurst (2012)	Sustainable supplier assessment	
		Lee, Kang, Hsu, and Hung (2009)	Green supplier selection	
		Lee, Nha Le, Genovese, and Koh (2012)	Green partner selection	
		Büyükoçkan (2012)	Green supplier evaluation	
		Lu, Wu, and Kuo (2007)	Green supplier evaluation	
		Çiğçi and Büyükoçkan (2011)	Green supplier evaluation	
		Handfield, Walton, Sroufe, and Melnyk (2002)	Supplier environmental performance assessment	
		DEA	Mirhedayatian, Azadi, and Saen (2014)	Green supply chain performance evaluation
		ANP	Hsu and Hu (2009)	Green supplier selection
Grey methods	Grey methods	Bali, Kose, and Gumus (2013)	Green supplier selection	
		Sahu, Datta, and Mahapatra (2012)	Green supplier appraisalment	
		Baskaran, Nachiappan, and Rahman (2012)	Suppliers' sustainability evaluation	
		Blome et al. (2014)	Green supplier development	
		Caniëls et al. (2013)	Green supplier development	
		Genovese, Koh, Lenny, and Esposito (2013)	Green supplier selection	
		Henri and Journeault (2008)	Environmental performance evaluation of manufacturing firms	
		Yang et al. (2010)	Supplier environmental performance management	
		Knowledge Base System (KBSD) using Case Based Reasoning (CBS)	Humphreys, Wong, and Chan (2003)	Environmental supplier selection
		Hybrid methods	DEA and ANP	Wen and Chi (2010)
Kuo and Lin (2012)	Green supplier selection			
ANP and TOPSIS	Akman and Pişkin (2013)			Green supplier evaluation
ANN, MADA, DEA, ANP	Kuo, Wang, and Tien (2010)			Green supplier selection
Multi-objective genetic algorithms (MOGA)	Yeh and Chuang (2011)			Green partner selection
Grey based DEMATEL	Fu et al. (2012)	Green supplier development program evaluation		
Methods dealing with uncertain data	Fuzzy AHP	Grisi, Guerra, and Naviglio (2010)	Green supplier performance evaluation	
		Lee et al. (2009)	Green supplier selection	
		Lu et al. (2007)	Green supplier evaluation	
		Fuzzy TOPSIS	Awasthi, Chauhan, and Goyal (2010)	Supplier environmental performance evaluation
		Shen, Olfat, Govindan, Khodaverdi, and Diabat (2013)	Green supplier performance evaluation	
	Fuzzy TOPSIS	Govindan, Rajendran, Sarkis, and Murugesan (in press) and Govindan, Khodaverdi, and Jafarian (2013)	Sustainable supplier performance evaluation	
		Tsai and Hung (2009)	Green supplier selection	
		Tuzkaya, Ozgen, Ozgen, and Tuzkaya (2009)	Environmental supplier performance evaluation	
		Bai and Sarkis (2010a)	Sustainable supplier selection	
		Büyükoçkan and Çiğçi (2012)	Green supplier evaluation	
Fuzzy goal programming	Kannan, Khodaverdi, Olfat, Jafarian, and Diabat (2013)	Supplier selection and order allocation		
Fuzzy ANP, Fuzzy PROMETHEE				
Grey system and rough set theory				
Fuzzy DEMATEL, ANP and TOPSIS				
Fuzzy AHP, Fuzzy TOPSIS, and Fuzzy multi objective linear programming (MOLP)				
Rule based fuzzy inference system	Amindoust, Ahmed, Saghafinia, and Bahreininejad (2012)	Sustainable supplier selection		

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