Chapter 2
A Big Data–Driven MCDM Model for Sustainable Supplier Selection

Beyzanur Cayir Ervural
http://orcid.org/0000-0002-0861-052X
Necmettin Erbakan University, Turkey

ABSTRACT

In response to increasing environmental degradation and sustainability pressures, supply chain management (SCM) has expanded its focus to include sustainability alongside traditional performance goals. This study examines the use of Big Data Analytics (BDA) integrated with three Multi-Criteria Decision-Making (MCDM) methods—WASPAS, MAUT, and COPRAS—to support sustainable SCM decisions. Criterion weights are determined using the CRITIC method, enabling a more objective and data-driven evaluation framework. The study highlights how real-time data from Internet of Things (IoT), Enterprise Resource Planning (ERP) systems, and external sources enhance the accuracy and adaptability of sustainability assessments. A case study on supplier selection and logistics management demonstrates the effectiveness of the proposed approach. The results highlight a research gap in the comparative analysis of MCDM techniques in the context of improving decision quality, responding more quickly to change, and sustainability-focused supply chains.

INTRODUCTION

In response to increasing global concerns over environmental degradation, social inequality, and economic instability, sustainability has become a fundamental dimension of supply chain management (SCM) in recent years. (Morana, 2013; Seuring

DOI: 10.4018/979-8-3373-6896-2.ch002

& Müller, 2008; Stefan Schaltegger et al., 2014). Once considered a minor goal of a company's operation, sustainability has now risen to being one of the most important indicators of a company's performance due to not only the forceful regulations but also the expectations from stakeholders and the marketplace (Contini & Peruzzini, 2022; Epstein & Roy, 2001). Supply chain models, which have been traditionally focused on cost-effectiveness and operational speed, cannot effectively meet the many complexities associated with sustainable performance. Therefore, supply chain executives have had to increasingly evaluate their supply chain strategies using a multidimensional perspective that integrates economic feasibility, environmental sustainability and social responsibility (Elkington, 1998).

Additionally, advancements in Big Data Analytics (BDA) have provided companies with a rich source of information to monitor, manage, and analyze the large amounts of diverse data they possess in real time. Information is derived from many sources including, but not limited to, Internet of Things (IoT) devices, Enterprise Resource Planning (ERP) solutions, social media data and third-party environmental and regulatory datasets (Alyahya & Agag, 2025). When used in conjunction with actionable data, BDA enables an organization to have greater visibility, agility and accuracy when making decisions. For this reason, Multi-Criteria Decision-Making (MCDM) methods are necessary for complicated real life issues. MCDM provides a systematic and tough framework for rating alternatives based on several, often conflicting criteria. In the area of sustainable SCM, the use of MCDM techniques has been extended to a wide range of decisions such as supplier selection, facility location, transportation planning, and product design (Govindan et al., 2013). Nonetheless, most current implementations depend on static, expert-driven input data - such as responses from surveys or Delphi methods - that do not acknowledge the ever-changing, data-rich environments in which today's supply chains are functioning. The merger of BDA with MCDM models is a potential, though largely unrecognized, way of resolving this issue, thus granting not only real-time responsiveness but also organized decision support. There is an increasing amount of research published in the academic world that shows the interest in the combination of BDA and sustainability. For example, Dubey et al. (2020) argue that BDA capabilities can be a major driver for the company to achieve environmental and social performance if they are deeply integrated with supply chain strategies. However, most of these studies, especially in comparative contexts, end without detailing the operational linkage between specific decision-making frameworks such as BDA and MCDM. Besides, most of the researches have only one MCDM technique (e.g., Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), or VIšekriterijumska Optimizacija I Kompromisno Rešenje (VIKOR)), and only a few have investigated the relative strengths and weaknesses of different methods when combined with current big data inputs.