

23rd CIRP Conference on Life Cycle Engineering

## Developing sustainable supply chains in developing countries

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### Abstract

Sustainability of supply chains is achieved through the consideration of the economic, environmental and social aspects in the decision making process. The majority of research concentrates on integrating two out of these three aspects, with limited inclusion of the social aspect. In developing countries, where the production supply chains are usually labour intensive, and where environmental regulations are still developing, both social and environmental aspects should be given considerable importance. This work presents a supply chain assessment model integrating the three dimensions of sustainability. An illustrative numerical example demonstrates how the proposed model may aid in the assessment and improvement of supply chain sustainability.

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Peer-review under responsibility of the scientific committee of the 23rd CIRP Conference on Life Cycle Engineering

**Keywords:** Sustainability; assessment; developing countries; supply chain;

### 1. Introduction

With the rise of globalization the role and importance of supply chain management has increased. Global supply chains commonly extend between industrialized and developing countries. Differences in economy, legislations, regulations and standards pose difficulties in managing such supply chains. Developing countries, usually playing the role of raw material suppliers or manufacturers, face problems which affect the performance of supply chains [1]. Common problems with developing countries include instability of governments and policies, corruption, labor intensive industries, deteriorated infrastructure and limited use of new technologies, underemployment, child labor, and low education level of the population [1]. Due to customer pressure and legislation in industrialized countries, sustainability of the supply chain is a main goal to achieve. Sustainable supply chain management is defined as “the management of material, information and capital flows as well as cooperation among companies along the supply chain

while integrating goals from all three dimensions of sustainable development, i.e., economic, environmental and social, which are derived from customer and stakeholder requirements” [2]. To achieve sustainability targets a coordination between the supply chain members is necessary. To preserve their position and role in the supply chain, each member has to conform to the environmental and social goals, while competitiveness would be achieved through the fulfillment of customer requirements and economic aspects [2]. Failure of one stage or player in the supply chain will affect the overall performance and competitiveness of the supply chain. Developing countries encounter additional challenge since their economic benefit relies on the exploitation of natural resources. Social implications of the production activities are highly neglected [3].

Thus there is a need to assess the performance of the whole supply chain with respect to the three dimensions of sustainability: economic, environmental, and social. Having such a collective measure, strategic, tactical, and operational

decision making will be facilitated to increase supply chain sustainability.

The remainder of this paper is structured as follows. In the following section a literature review concerning sustainability assessment in supply chains with an emphasis laid on the triple bottom line approach and its application to developing countries is presented. Section 3 describes the proposed methodology for assessing supply chains sustainability in global supply chains and proposes a set of indicators to measure the economic, environmental and social performance of the supply chain. To illustrate the implementation of the proposed approach, a numerical example is given in Section 4 and the results are presented and discussed. Finally, conclusions are drawn and future research avenues are highlighted in Section 5.

## 2. Literature review

Numerous research efforts have been dedicated to the assessment of the sustainability of supply chains. Few have considered all three dimensions of sustainability aspects. The majority have added the environmental aspect to the traditional economic dimension, leaving the social aspect the least addressed in the literature [4, 5]. This is in part due to the qualitative nature of social aspects and the difficulty encountered in quantifying it [6]. The purpose of the current review is twofold. First, it reviews the existent research which has considered all three pillars of sustainability in supply chain. Second, it presents a state of the art of sustainable supply chains in developing countries.

### 2.1. Measuring sustainability in supply chains

A number of sustainability measures have been presented in the literature and used in the context of supply chains to aid stakeholders in making tactical and strategic decisions. In [7] an optimization supply chain network design model is proposed. The objective was to maximize sustainability expressed as linear benefit function of three components representing the economic, social and environmental dimensions of sustainability. Environmental measures used were based on energy consumption in the different supply chain echelons. The social indicator used is the one for health and safety, which covered worker safety for technologies and community safety for sites. A multi-objective linear programming model was formulated in [6] to design and plan a closed loop supply chain.

An analytical model is proposed in [8] to assess the sustainability of the supply chain via a triad. The developed assessment framework focused on supply chain practices and how they affect the sustainability of the supply chain. The framework included fifteen indicators representing the three dimensions of sustainability. These were broken down to sixty seven subfields covering economic contribution, environmental impact and social responsibility.

A fuzzy inference system was used in [9] to assess the sustainability of suppliers in medical device industry regarding the three dimensions of sustainability. Three scores

measuring the three dimensions of sustainability are derived, and their average represents the overall supplier performance.

A probabilistic model for assessing sustainability of supply chain over time is presented in [10]. In their model the sustainability of a supply chain is defined by the probability that a supply chain strength exceeds its challenges.

The supply chain operation reference (SCOR) model has been extended by the Logistics Management Institute (LMI) to GreenSCOR which includes the environmental aspects of the supply chain [11]. Yet, the application of GreenSCOR is still scarce [12]. A number of SCOR metrics have been devised by the Supply Chain Council. These are categorized in five performance attributes: reliability, responsiveness, agility, costs, and assets management efficiency. These consider the customer and the internal operation of the supply chain. It is evident that a measure for sustainability considering the triple bottom line approach is not present.

### 2.2. Sustainable supply chains in developing countries

The research on sustainable supply chains in developing countries is scarce [14]. The main challenge faced in supply chain management is the coordination between developing and industrialized countries in view of the difference in legislations. Two challenges in decision making for supply chains are present [3]: First, firms tend to build stronger relationships with their suppliers since more design and production activities may be delegated to them. Second, an increasing number of organizations are incorporated in the supply chain due to the focus on core competencies. With the focal company considered responsible for the performance and actions of their suppliers affecting the environment and society [15], the assessment of each supply chain actor and the overall supply chain sustainability seems vital for decision making.

A number of empirical research exists for sustainability practices in supply chains in developing countries [14]. In [16] it is argued that in developing countries the dynamicity and uncertainty of business environments and the lack of institutions prevent supply chains from learning, innovating and thus hinder the sustainability target achievement. Through a case study in Brazil, four characteristics of developing countries affecting the performance of supply chains are identified: corruption, lack of infrastructure, pressing social problems in urban areas, and informality [16]. Akamp and Müller [1] concluded that supplier selection and evaluation, supplier development and supplier integration directly affect the supplier performance in developing countries.

In summary, a limited number of measures have been developed for assessing sustainability of supply chains considering the triple bottom line. Such measures are vital to aid in the decision making process on both strategic and tactical levels. The barrier to incorporating all three dimensions is the difficulty in quantifying the social aspects and the integration of all three pillars. Aggregation methods encompass multi-objective optimization and multi-criteria decision making. Global supply chains extending between industrialized and developing countries face additional complexity of coordination in view of the differences in

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