Sustainability Assessment Framework for Dynamic Supply Chains

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Abstract

The recent past has shown that many companies stressed from the competition, have reduced manufacturing costs as well implemented sustainable practices as much as possible. And yet this effort has proved to be insufficient. This reality is forcing the companies and managers to address the problem of competitiveness and sustainability in a holistic way, by considering the entire supply chain. Due to this pressure from supply chain stakeholders to a comprehensive sustainability assessment of the entire network, extended “performance metrics” are required not only on the economic value of a business, but also in its environmental and social impacts. Increasing numbers of organizations report a massive volume of data, with low consistency and high variability in data quality, and a dispersion of indicators, making it necessary to develop and implement new approaches for Supply Cain Management (SCM) sustainable performance assessment. This paper focuses on this topic, presenting a new approach for performance and risk assessment within dynamic supply chain networks, supported in a new and comprehensive Sustainability Assessment Framework (SAF).

Keywords

Supply Chain, Supply Chain Management, Sustainability Assessment, Sustainable Performance, Assessment Framework.

1. Introduction

Sustainability is defined as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (Dee, 2010). According to the UN 2005 World Summit it was noted that sustainability requires the reconciliation of environmental, social and economic demands - the "three pillars" of sustainability.

The expression sustainability, which increasingly refers to an integration of social, environmental, and economic responsibilities, has begun to grow their presence in the literature related to management topics.

In addition, companies are beginning to rapidly embed the term sustainability in their practices. In the 250 largest companies in the world (G250), 95 percent now report on their corporate responsibility (CR) activities which consider environmental, social, and economic issues, including almost 60 percent of China's largest companies that already report using corporate responsibility metrics. This figures contrast to the primary emphasis on environmental reporting in 1999. In addition, recent reports have shown that integrating CR into products and markets to increase profitability and improve market share, requires companies to significantly change their processes and approach to product development and supply chain efficiencies (KPMG, 2011).

Particularly within Supply Chain Networks, the decision making related with sustainability policies and practices is a critical issue for the future of each stakeholder of the network. Sustainability networks must ensure that economic, environmental and social axes are fully aligned within each partner.

2183-3060/2014/0101-042

The ongoing business development demonstrated that the corporate responsibility does not start and end with each own core business, but extends upstream through the whole supply chain from the raw materials manufacturer up to downstream, the end user (Beske, Koplin, & Seuring, 2008). Due to this pressure from supply chain stakeholders to a comprehensive sustainability assessment of the entire network, extended "performance metrics" are required not only on the economic value of a business, but also in its environmental and social impacts.

In line with this reality and needs, the present research work proposes to provide answers to the lack of appropriate organizational reference models, conceptual frameworks and services for sustainability assessment of supply chain networks. A second topic that motivates the present work is the inadequacy of the current supporting technologies and tools to enable the creation and configuration of sustainable supply networks namely for innovative consumer cooperative environments for products and services design (dynamic supply chains).

Starting from the previous identified problems, this paper presents a new approach for performance assessment within supply chain networks, supported in a new and comprehensive Sustainability Assessment Framework (SAF).

2. Sustainable Supply Chain Frameworks: a review of literature

In this section, it is reviewed the literature available on sustainable supply chain and management in order to identify the challenges and the shortcomings that the network stakeholders are facing in assessing and evaluating the current management practices, policies and decision support systems.

The concept of supply chain management goes back to pioneering work from Forrester (1958), who identified the dynamics of response to demand changes in supply chains. This author identified the distortion in demand created by the dynamic complexity present in transferring demand from end users along a chain of supply to manufacturers and material suppliers. A key result of this work was the identification of the interdependence between stakeholders in supply chains in terms of information data flows, and therefore the need for an integrated management of all the flows in the network. It is recognized that one of the most important prerequisites for successful supply chain management is the integration of information flows, material flows, and all the business processes within a supply chain network (Lambert, Cooper, & Pagh, 1998).

On the other hand, the ability to reach the markets faster than the competition with the right products, the capacity to meet the demands of customers with increasingly faster delivery times, and to ensure that the supply chains can be synchronized to meet the fluctuations of demand, is clearly of critical importance in this era of time-based competition (Stalk Jr, 1998).

At the fourth quarter of the twentieth century, comes to public attention the topic of sustainable development, placing companies as central actors in this discussion and debate. This was especially the case for companies that are more visible to the final consumer, as they were likely to come under pressure from stakeholders, e.g. customer, governmental and non-governmental organizations. These companies are asked to consider environmental and social problems observed in their supply chain. Since then, an increasingly number of companies has pursued proactive approaches to sustainable supply chain management. Such triggers have increased interest in green/environmental or sustainable supply chain management (Bowen, Cousins, Lamming, & Farukt, 2001; Seuring, 2004).

From the perspective of sustainability, the research literature identifies basically two distinct strategies for sustainable supply chain management practices: supplier management for risks and performance assessment; and supply chain management for sustainable products (mainly in the green/environmental aspects) (Seuring & Müller, 2008). Starting from the perspective of planning and supporting the implementation of sustainable supply chain management strategies, the Supply Chain Operations Reference (SCOR) Model (see Figure 1), which was developed by the experts and practitioners of the Supply Chain Council, is a major framework for supply chain planning that features supply chain management practices and business process reengineering. With version 10.0 of SCOR, the model includes process elements addressing environmental aspects of managing a supply chain called GreenScor. These additions allow the SCOR model to be used as a green supply chain management tool, allowing managers to design and optimize supply chain operations with sustainability in mind (Council, 2010).

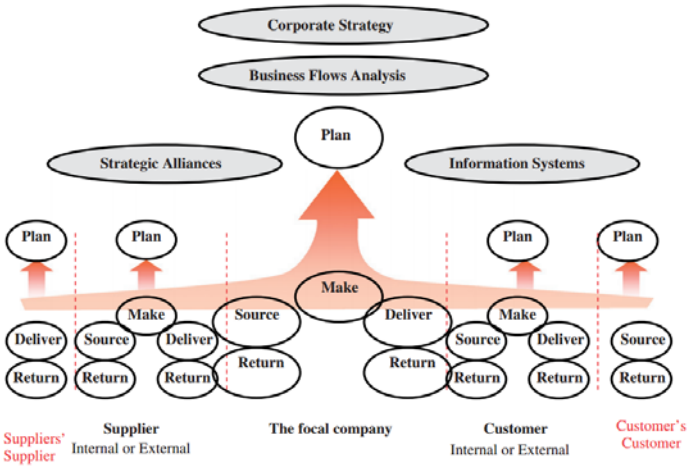

Figure 1 - Overall view of the SCOR model

Another supply network reference models presented in literature that addresses the topic of sustainability in the SCM frameworks is the CoReNet reference model (Bastos, Franchini, Azevedo, & Fornasiero, 2012) based in the SMART model proposed by Filos and Banahan (Filos & Banahan, 2001) in 2001. This CoReNet model presented in the Figure 2 allows the definition of practices, technological and performance models for collaborative networks according to the following four main dimensions: (1) Knowledge – to map partners' competencies to be shared within the network in terms of products and processes; (2) Information & Communication Technologies (ICTs) – to support the requirements for the implementation of ICT services at different process levels along the network; (3) Organizational – to provide specifications of the organizational changes for SMEs for structuring supply networks in small series production, and (4) Sustainability - is intended to support the enterprises in the developing of an eco-compatible approach for their products and processes coherent with eco-efficiency objective of the sustainability dimension.

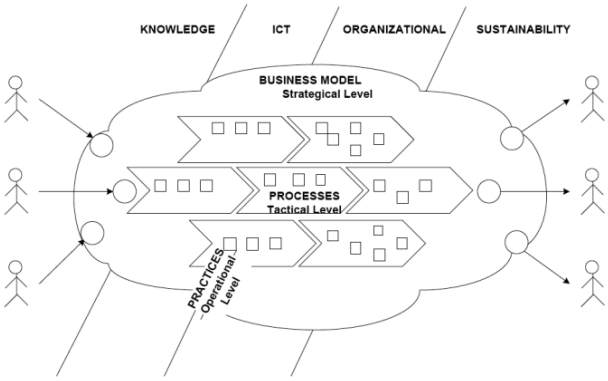

Figure 2 - CoReNet Reference Model Context Diagram

This approach aimed to develop a systematic strategy for the supply network configuration, coupled with a detailed definition and characterization of the operative level of processes and activities along four main dimensions.

3. Sustainability Framework

This section presents the proposed sustainability framework by revealing the projected architecture and the listing of the main sustainability indicators and dimensions. The Sustainability Framework presented in this

paper is based in the CoReNet reference model (Bastos et al., 2012) and extends the scope of its definition focusing in the sustainability dimension framework.

From the literature review, it is clear that, sustainability and environmental risk assessment can be performed through a system modeling approach, where both quantitative and qualitative techniques should be combined.

4.1. Conceptual Foundations

The proposed Sustainability Framework (SF), according to Figure 3, addresses the three levels of supply chain sustainability decision making, the Strategic, the Tactical and the Operational level. Regarding the strategic level, the business model framework proposed by Osterwalder (Osterwalder & Pigneur, 2010) is applied as conceptual approach. The model maps the most important building blocks that influence the definition of the value proposition. The idea is to instantiate the model to the specific sector case.

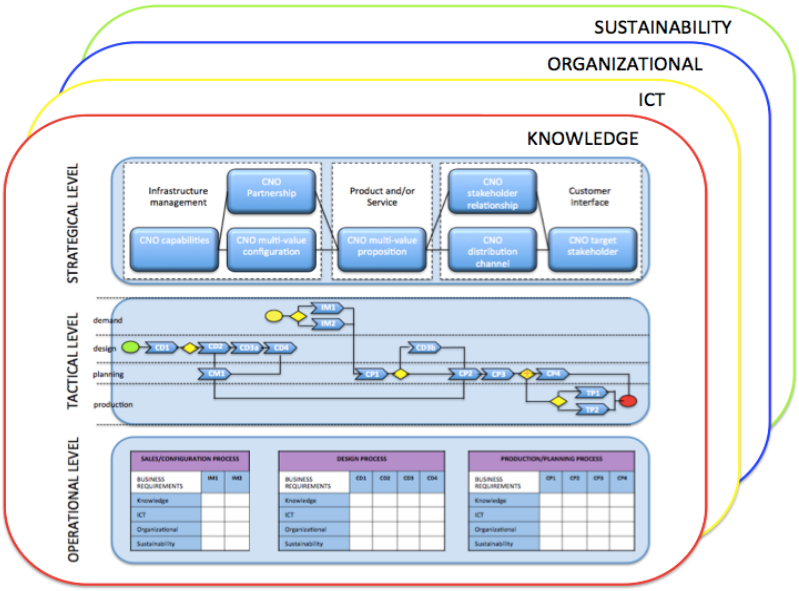

Figure 3 – Sustainability Framework Schema

In the tactical level of the SF, the most important processes critical for the assessment of the business model have been identified according to the requirements mapped in the business case analysis. These processes have been formalized according to the Business Process Model Notation (BPMN). At the tactical level, a high level view summarizes the whole process flow, highlighting the sequence and the interrelations between the different sub processes involved in each phase, identifying the relevant indicators and metrics.

The operative level guides the companies in the implementation or reengineering of the business processes with the specific sustainability practices, KPIs, templates and all information and materials useful to support the processes considered and the management of all related activities.

All of these three decision making levels are framed in the four dimensions presented in the SF: Knowledge; ICT; Organizational and Sustainability.

4.2. Methodology

In line with the Sustainability Framework Schema vision, the sustainability analysis can be seen as a special tool for decision making assessment in medium and long terms. In fact, one of the main achievements of this type of assessment is based on the identification of driven factors that can provide information about the sustainable performance of a complex supply chain system.

One key pillar in this work is based on the idea that in order to implement a performance management strategy assessment for sustainability issues, it is critical to have a well defined data model, capable to structure a series of Sustainability Indicators (SI).

Because sustainable development encompasses three different pillars and their interactions, there is a vast range of relevant indicators requiring a reference model in order to be framed in an organised structure. In line with this, the first stage of the sustainability framework definition is based on the necessity of harmonize an exhaustive list of potential SIs, as well as a data model for structuring these indicators. Since the sustainability concept should be flexible enough to adapt to each system's characteristics, it is necessary to implement a system thinking approach in the identification and characterization of the main feedback loops presented in the supply chain network system. The Figure 4 presents the overall Sustainability Framework Pyramid in which is depicted the methodology behind the SF.

Aiming to improve the quantity of information available to decision makers, the second layer of the sustainability framework is responsible to compile the information existing into a sustainability index for each perspective of the sustainable concept. This way, it becomes possible to evaluate the impact of a specific supply chain topology into a Knowledge; ICT; Organizational and Sustainability dimension, based not only on the measures obtained for each SIs, but also taking into account the systems dynamics and stakeholder's visions. In order to handle with the subjectivities imposed by this type of performance assessment, a Fuzzy Logic approach is adopted.

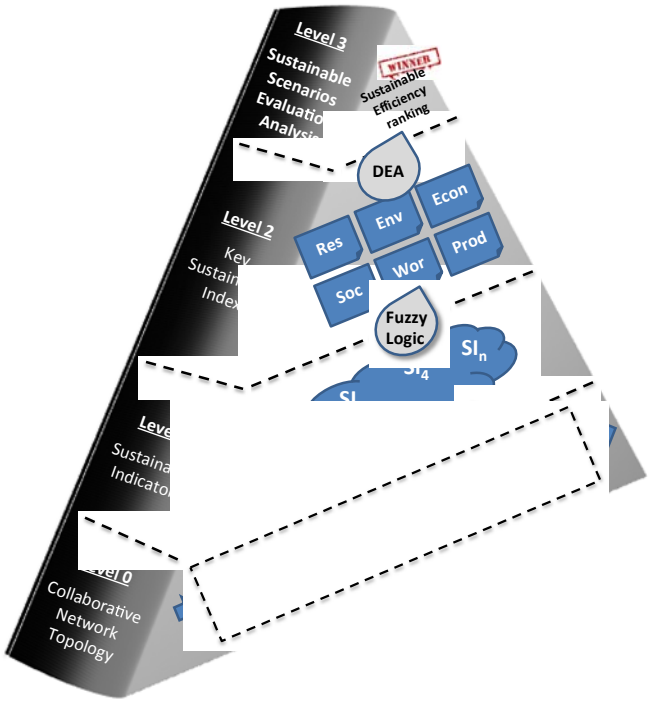

Figure 4 – Sustainability Framework Pyramid

The third level of the sustainable framework pyramid is mainly oriented to SCs topology benchmarking. Based on the results obtained from the previous stage of the framework it is expected to select from a list of possible SC topologies the suitable one that, for a specific scope, presents a better sustainable efficiency index.

In sum, the Sustainability Framework was developed in order to empower the supply chain stakeholders for the supply network assessment in the four sustainability dimensions. Initially, the network topology is identified and instantiated. At this stage it is critically to not only understand the global strategy of the network but also to be clear which are the partners performing at this network as well as their roles and aspirations. Following, a series of sustainable indicators should be selected and defined in order to extract in a structured way the correct information related to the sustainable development. Usually the six main features assessed are: energy and material use, natural environment, community development and social justice, economic performance,

employees, and products. For each of these features, a key sustainable index should be calculated based on a fuzzy approach that calculates each of these metrics taking into account the different roles and perspectives of the stakeholders involved into the supply network.

Finally, the efficiency and performance of a specific network can be calculated in terms of sustainability. This can be an important feature for world-class organizations since it will allow decision makers to compare their strategies with their competition and perform valuable benchmarking.

6. Conclusions and Further Work

Specially on networked organizations such as supply chain, the sustainability issues arises as relevant in performance evaluation and risk assessment for competitiveness of the network. In line with this, the current work presents the main concept and vision of Sustainability Framework supported on a set of key sustainability indicators as means to evaluate the longer-term implications of current decisions and behaviors in supply chains. The present framework allows the creation of innovative collaborative environments enabling dynamic supply chain companies to produce and deliver small series of specialized and customized high value added products. It also allows a formalization of a methodology that can be applied to companies to support the sustainability assessment of methods and tools for product design, planning, production activities and rapid manufacturing technologies. Equally enables supply networks stakeholders to access set of key sustainability indicators as means to evaluate the longer-term implications of current decisions and behaviours in supply chains.

As future work, it is expectable to design and setup a simple but reliable pilot case, based on a real industrial scenario, where it will be possible to test and validate the framework here presented.

Acknowledgments

Project Best Case is co-financed by the North Portugal Regional Operational Programme (ON.2 – O Novo Norte), under the National Strategic Reference Framework (NSRF), through the European Regional Development Fund (ERDF).

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