Sustainable Supply Chain Planning: A framework to facilitate economic, environmental and social responsibility

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Abstract
Sustainable supply chain planning is key to operations. The presented model in this study covers social, environmental and economic aspects of sustainability. It has been developed and validated using content analysis of academic literature, industry publications, company reports and sustainability frameworks.

Keywords: Supply chain planning, sustainability, content analysis

Introduction
Sustainability has evolved from a buzzword to a market capitalization strategy. The Brundtland Report (1987), titled Our Common Future, defined it as “a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The report supported the concerns of stakeholders pertinent to environmental and social responsibilities of the corporate sector. Following this, governments were pressed to play their pivotal roles in realizing the goal of the Brundtland Commission through protests by non-governmental organizations (NGOs) against human rights violations, fieldwork by environmentalists, the UN Rio Declaration, mass media coverage of ecological degradation and consumer pressure. The consequent legislations in many parts of the world then forced the business world to measure the performance of its operations based on the three P’s of people, profit and planet, sometimes referred to as the ‘Triple Bottom Line’ (TBL) (Elkington 1998). As a result, numerous organizations have tried to adopt environment-friendly and socially-responsible practices. However, these efforts have mostly resulted in inconsequential improvements. One of the main reasons is that the implementations lacked the supply chain perspective (Baumgartner and Ebner 2010; Lubin and Esty 2010). Researchers have argued that the goals of sustainable development can only be realized if efforts are made along firms’ supply chains (SC). In this regard, Brockhaus el al. (2013) in their recent literature review concluded that “the state of SSCM [Sustainable Supply Chain Management] implementation in practice can still be considered low.” This is due to the absence of a comprehensive and holistic model that could help to implement sustainability in a supply chain. Therefore, there is a dire need to operationalize the concept of SSCM for a focal firm. This paper would make an effort in this regard by developing a model for sustainable supply chain planning (SPlng) which is at the core of SSCM.
Sustainable Supply Chain Planning
In supply chain management literature, researchers have separately investigated various environmental, social and economic issues. Recently, work by Carter and Jennings (2002, 2004) interconnected concepts of environment, safety, human rights, community, diversity and philanthropy into broader constructs of logistics social responsibility (LSR) and purchasing social responsibility (PSR). Also, Carter and Rogers (2008) developed a conceptual high level framework for sustainable supply chain management based on TBL. Badurdeen et al. (2009, p. 57) defined SSCM as “Involvement of the planning and management of sourcing, procurement, conversion and logistics activities involved during pre-manufacturing, manufacturing, use and post-use stages in the life cycle in closed-loop through multiple life-cycles with seamless information sharing about all product life-cycle stages between companies by explicitly considering the social and environmental implications to achieve a shared vision.” Clearly, planning is one of the most important but challenging areas in a supply chain. In the last two decades, the focus of SC planning has shifted from the shop floor to a holistic view of various logistics, production and procurement activities within a focal firm. A major driver of this shift is the consumer call for environment-friendly and socially responsible operations. Hence cooperation has increased between suppliers, focal firm and logistics providers. This has mounted enormous pressure on the ‘planning’ process to expand its purview from a factory floor activity to a strategic function that could oversee operations in other supply chain processes and initiate, monitor and implement ‘sustainable practices’. However, the literature lacks the insight into how supply chain planning can help to realize the goal of sustainable development. This paper will make an effort to answer the following research questions (RQs):

RQ1: How can supply chain planning play a role in achieving sustainability objectives?
RQ2: What are the major dimensions and measures of sustainable supply chain planning constructs?
RQ3: What are the important activities that constitute sustainable supply chain planning?

These research questions are answered by developing a theoretical and conceptual model for sustainable supply chain planning (SPlng) through a rigorous and systematic methodology. The balance of this research paper will present the important elements of the methodology; brief discussion on the dimensions and measures of SPlng process; theoretical and conceptual model for SPlng; further research directions and concluding remarks.

Scope of the Research Paper
This paper will discuss the ‘sustainable supply chain planning’ construct in the context of a focal firm’s supply chain. It will present holistic dimensions and measures of sustainable supply chain planning (SPlng) regardless of the context (industry, country or business domain). It should also be noted that this research paper is part of a broader Ph.D. study in which the SPlng model is contextualized for the Australian food industry. The discussion in this paper is limited to high-level dimensions and measures which can be adapted to any environment. Consequently, this paper will ‘not’ debate specific strategies, techniques and models for inventory management, postponement, vendor managed inventory (VMI), supply contracts, product design, safety stock, Enterprise Resource Planning (ERP) solutions and integration of supply chain actors.
Methodology
The dimensions and measures for SPLng were developed through detailed analysis of relevant academic publications. The steps and phases of the methodology are discussed below:

Step 1 – Literature Collection Process (SPLng)
In order to operationalize SPLng, it was decided to systematically analyse the peer-reviewed research articles published during the last 20 years, from 1992 to 2012. The ‘filtration criteria’ excluded all the papers written in a language other than English; and papers with a strong focus on pure mathematical approaches, rigorous quantitative modelling, human psychology, political science and organizational governance. The keyword search was conducted in major electronic databases and library services such as Emerald, ScienceDirect, Wiley and Springer. Initially, search strings consisting of the terms ‘sustainable supply chain management’ and ‘sustainability’ AND ‘supply chain’ resulted in 633 articles. Next, search strings consisting of terms ‘sustainable supply chain planning’; (sustainability) AND (supply chain planning); and (sustainable OR ethical OR green) AND (supply chain) AND (planning) resulted in 433 articles. The perusal of abstracts, application of filtration criteria, and elimination of duplications resulted in 88 articles pertinent to SPLng and 78 papers related to general sustainable supply chain management (GSSCM). Finally, these 166 papers were validated against the publication sample used in seminal ‘review papers’ of Seuring and Muller (2008) and Ashby et al. (2012) to reduce the possibility that an important research study was overlooked.

Step 2 – Literature Analysis Using NVivo
The dataset from Step 1 was analysed through a three-phased methodology which involved content and thematic analysis; inductive and deductive approach; constant review and comparison; analysis strategy suggested by Richards (2004); and use of qualitative data analysis (QDA) software, as shown in Figure 1. It must be noted that these strategies and techniques were selected after extensive deliberation and brainstorming. For instance, NVivo was selected as it has state-of-the-art features to organize unstructured information, powerful query and modelling tools, and a user-friendly interface. Also, NVivo does not dictate a specific analysis procedure. Rather, it provides general conceptual elements and analytical tools so that researchers can tailor the coding mechanism according to their research design (Tesch 1990). The analysis strategy recommended by Richards (2004) was used in all the three phases. It consists of four steps: (1) interrogate interpretations; (2) scope data for profound analysis; (3) achieve saturation to ensure completeness; and (4) maintain audit trails. Thematic analysis was used in Phase I while content analysis was used in Phases II and III. This decision was based on the understanding that both analyses are similar, as they allow for qualitative analysis, but thematic analysis concentrates only on the qualitative dimensions of the text while content analysis also focuses on the descriptive analysis of the attributes of selected text (Gbrich 2007). Both analytical techniques used coding to examine data in each phase using the NVivo software. According to Lockyer (2004), coding is “a systematic way in which to condense extensive data sets into smaller analyzable units through the creation of categories and concepts derived from the data.” In NVivo, coding was done through ‘nodes’ that may be understood as material containers or objects representing an idea or a concept. Initially, ‘free nodes’ (open coding) were developed which represented emerging themes, and these were later grouped into ‘tree nodes’ that represented various dimensions and measures for the sustainable supply chain planning construct.
In **Phase I**, high level sustainability frameworks such as Natural Capitalism, Biomimicry, Cradle to Cradle, Life Cycle Analysis, Social Return on Investment, The Natural Step, Sustainability Helix and Triple Bottom Line were analysed through NVivo (Cook 2004; McDonough and Braungart 2010; Shedroff 2009). Thematic analysis helped to develop a basic taxonomy of themes discussed in these frameworks. It became evident that at its core, sustainability is about efficiency, risk mitigation, systems perspective, resilient enterprises, diversity of workforce, decentralization of power, control and resources, and institutionalization of cooperation, collaboration and competition among the stakeholders for continuous innovation. Thorough analysis showed that all the frameworks focused on the three main dimensions of sustainability – economic, social and environmental. The terminology used by them might be different but focal themes were very similar such as biodiversity, air quality, water contamination, toxic materials, hazardous emissions, renewable resources, recycling, freedom of speech, work-life balance, child labour, regulatory compliance, transparency, accountability, risk management, cost-reduction, product design and economic value.

In **Phase II**, the publication sample of ‘166’ papers was imported into the NVivo software through its ‘data import’ feature. Content analysis was then carried out using the strategy suggested by Richards (2004). Initially, preliminary ‘interrogation’ was done and general sustainability themes identified in Phase I were used as the guiding principle to extract sustainability dimensions for the sustainable planning construct. Papers related to SPLng and GSSCM were coded onto the ‘sustainable planning’ node. Text search query, word frequency query, tree maps, tag clouds, cluster analysis and summary tables were used for analysis. The resulting ideas or themes were scrupulously studied from the literature, thoroughly debated, critically analysed and compared with each other. They were then coded onto new free nodes. Next, ‘scoping’ was done which refers to profound analysis into a specified subset of data (Gibbs 2002). Each broader theme identified during interrogation was meticulously studied and further refined into many new free nodes (or codes). The scoping of data, based on constant review and comparison, continued until a clear repetition was observed in the new nodes by the authors. This meant that ‘saturation’ was achieved and all free nodes sufficiently covered the sustainable planning construct under examination (Selden 2005). Once saturation was achieved, free nodes that represented similar technical concepts were connected with each other to form ‘tree nodes’. These tree nodes actually represented the dimensions and measures for the sustainable planning construct. Finally, ‘log and audit trails’ were maintained in all phases to keep track of various decisions and judgements, as coding of the SPLng construct was a ‘highly iterative and non-linear’ process.

In **Phase III**, ‘data triangulation’ was used for ‘face validation’ of the output of Phase II. O’Donoghue and Punch (2004) stated that triangulation is a “method of cross-checking data from multiple sources to search for regularities in the research data.” Major themes discussed in the Global Reporting Initiative (GRI) framework and highlighted by companies in their annual sustainability reports were determined through content analysis and tools provided in the NVivo software. Once themes were finalized, these were compared with the output of Phase II. All major inconsistencies triggered further literature review, analysis and recoding of nodes. Thus ‘constant review and comparison’ was carried out and the academic literature was rigorously examined to extract evidence for further addition, modification or deletion of codes. Consequently, valid sustainability dimensions and measures emerged for the SPLng construct.
Step 1 – Literature Collection Process for Sustainable Supply Chain Planning (SPlnng)

- i. Search based on keywords ‘sustainable supply chain management’ and ‘sustainability’ AND ‘supply chain’
- ii. Search based on keywords ‘sustainable supply chain planning’, ‘sustainability’ AND ‘supply chain planning’ and (sustainable OR ethical OR green) AND (supply chain) AND (planning)
- iii. Validation of dataset of 166 articles against the publication sample used by Seuring and Muller (2008) and Ashby et al. (2012)

Step 2 – Literature Analysis Using NVivo

- Deliberation, Brainstorming & Rigorous Perusal of Literature
- NVivo Software
  - Free Nodes (open coding)
  - NVivo Tools (Word Frequency Query, Tag Clouds, Tree Maps) were used to identify themes
  - Themes finalized at data saturation

Input
- NVivo Software
  - Development of High Level Sustainability Themes

Output
- High Level Sustainability Themes

Thematic Analysis
- Content Analysis
- Content Analysis

Step 3 – Literature Analysis Using NVivo

- Constant Review & Comparison
- Input
  - High Level Sustainability Themes & dataset of 166 academic articles

Output
- Dimensions & Measures for SPlnng Construct

Inductive & Deductive Approach
- Inductive & Non-Linear Process

Input
- NVivo Software
  - Free Nodes (open coding)
  - Free nodes clustered into tree nodes & then high level categories

Output
- Dimensions & Measures for SPlnng Construct

Dimensions & Measures for SPlnng Construct, GRI Framework & Annual Sustainability Reports of top 10 firms

Data Triangulation was used and SPlnng Dimensions & Measures were compared with GRI Framework and Annual Sustainability Reports of top 10 firms in order to ensure completeness & relevance

Final Output
- Relevant Dimensions & Measures for SPlnng Construct

Strategy: data interrogation, scoping, saturation & audit trails

Figure 1: Methodological Steps for Identification of Dimensions and Measures of SPlnng Construct
Dimensions and Measures of Sustainable Supply Chain Planning

Content analysis showed that the planning process is at the core of a sustainable supply chain as it furnishes high level institutional policies and chalks out risk mitigation strategies. The planning process also performs accurate demand and supply planning activities, and contributes towards sustainable new product development. These dimensions of SPIng, along with their measures, are discussed below and the hypothesized conceptual model is shown in Figure 2.

Institutional Policies

Institutional supply chain policies are defined as a set of detailed protocols that apply to all supply chain processes (procurement, production, transportation, warehousing and reverse logistics) within a focal firm. The institutional policies are mainly related to stakeholders (internal and external) and operations (Hartman et al. 1999; Zhu and Sarkis 2007). These policies must ensure that internal stakeholders are satisfied, fully motivated to perform their job and their skillsets are optimally utilized. This is only possible if the planning department ensures the following: diversity of the workforce; equal opportunities to everyone; elimination of discrimination and harassment from the workplace; periodical training of the employees; and fair remuneration and working conditions. In addition, prior research shows that institutional policies should also take care of external stakeholders (customers, consumers and society at large) by ensuring that all SC departments contribute towards communal projects related to health, education, sports and infrastructure as well as conduct customer satisfaction surveys on a periodical basis. It must also closely observe that all SC operations are free of corruption, bribery or any kind of illegal activities. Finally, it should devise strategies that could stimulate continuous improvement in processes pertinent to material acquisition, production, delivery and reverse logistics (Closs et al. 2011; Sharfman et al. 2009; Svensson 2009).

H1: Institutional policies related to stakeholders (external and internal) and operations are positively related to sustainable supply chain planning.

Risk Mitigation

Risk mitigation in supply chains is a very broad field and researchers have debated about different kinds of risks and mitigation strategies. Punniyamoorthy et al. (2011) stated that, typically, risks are related to supply, manufacturing, demand, logistics, information and environment. Often, particular supply chain departments manage these risks, and the literature does not explicitly articulate the role of the planning department in risk mitigation. Nevertheless, content analysis and consultation with industry experts revealed that the planning department acts as central headquarters for the remaining supply chain functions and should deal with high-level risks that have firm-wide impact. Therefore, the organization should have (1) a documented and periodically tested Business Continuity Plan (BCP) to ensure smooth operations in the wake of any IT Issues (e.g., server crash, data viruses, cyber-attacks and hacking); (2) a survival plan to mitigate risk of any natural disasters (e.g., floods, earthquakes and bush fire); (3) an emergency plan, to minimise harm to employees and local community, in the event of any site disaster; and (4) backup suppliers in case the deliveries from primary suppliers are disrupted due to bad crops, flooding and pests (Chen and Fan 2012; Cousins et al. 2004; Foerstl et al. 2010; Norman and Jansson 2004).

H2: Mitigation of risks against natural disasters, cyber attacks, fire emergencies and supply uncertainty is positively related to sustainable supply chain planning.
Demand and Supply Planning
Demand and supply planning is one of the most critical functions in any organization. It mainly encompasses forecasting (or demand planning) and production planning that forms the basis for materials requirements planning (MRP). It also helps in decision-making at various planning levels (i.e., strategic, tactical and operational) consisting of different planning horizons (long, medium and short-term) (Kovacs 2004). Another important aspect of this dimension is that of collaborative planning with internal corporate functions (such as sales and marketing) and external partners (such as customers and suppliers) which can lead to low inventory level through vendor managed inventory (VMI), and reduced costs due to better visibility for all supply chain partners. This dimension of planning must focus on improving demand forecast accuracy, completion of production plans, and effective collaborative planning (Hugo and Pistikopoulos 2005; Partidario and Vergragt 2002).

H3: Demand and supply planning activities are positively related to sustainable supply chain planning.

New Product Development
New product development (NPD) can be conceptualized as comprising eight stages, viz., idea generation, screening, conceptualization, business analysis, market testing, technical implementation, commercialization and pricing. Organizations usually consider NPD as the first step in the overall process of product lifecycle management. Studies have shown that 80 percent of any product’s ecological costs and impacts are established during its design phase (Shedroff 2009). Thus, the supply chain planning function must ensure that, in its ‘product design’, the long-term environmental and social impact could be minimized. Elimination of toxic materials, reduction in weight and size of the product, and the minimization of product resource requirements (water, energy and materials) would certainly ameliorate the supply chain’s sustainability outlook (Boons 1998; Seuring 2011).

H4: Collaboration with Brand Managers and Suppliers for new product development is positively related to sustainable supply chain planning.

Sustainable Supply Chain Planning Model
The sustainable supply chain planning model in Figure 3 shows all the dimensions (4) and measures (26) discussed above. It groups the measures with regard to their ‘primary impact’ on various dimensions of sustainability. It is observed that there are very few elements that affect
only a single aspect of sustainability. About 46 percent of the elements have a double impact and 23 percent have a triple impact. Moreover, the SPPlng model shows that almost all the measures (85 percent) improve the economic value of the company in addition to social well-being or environmental quality. Table 1 outlines all the dimensions and measures of the sustainable supply chain planning (SPPlng) construct while Figure 3 provides a graphical version.

**Table 1 – Sustainable Supply Chain Planning (SPPlng) Dimensions and Measures**

<table>
<thead>
<tr>
<th>SPPlng Dimensions</th>
<th>Sustainable Supply Chain Planning Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institutional Policies (IP)</strong></td>
<td>Corruption Free Operations (CFO), Transparent Market Practices (TMP), Communal Welfare Projects (CWP), Customer Satisfaction Survey (CSS), Employee Training &amp; Development (ETD), Workforce Diversity (WDI), Equal Opportunity Employer (EOE), Workplace Discrimination (WDS), Employee Backup Planning (EBP), Continuous Improvement (CI) and Research and Development (R&amp;D)</td>
</tr>
<tr>
<td><strong>Risk Mitigation (RM)</strong></td>
<td>Business Continuity Plan (BCP), Natural Disaster Survival Plan (NDSP), Backup Suppliers (BS) and Emergency Plan (EP)</td>
</tr>
<tr>
<td><strong>Demand &amp; Supply Planning (D&amp;SP)</strong></td>
<td>Demand Forecast Accuracy (DFA), Collaborative Planning (CP) and Accurate Production Scheduling (APS)</td>
</tr>
</tbody>
</table>

**Figure 3 – Sustainable Supply Chain Planning Model**
Further Research Directions and Conclusion

This piece of research is embedded in academic literature. The model has vital theoretical and practical implications. Adoption of sustainability practices help to improve the reputation of the firm, which is directly linked with profitability as per the prior research (Elizabeth 2002; Kramer and Porter 2007; Schiebel and Pochtrager 2003). The SPIng model also supports these results and shows that initiatives to address social and environmental dimensions of sustainability can lead to financial benefits. Supply chain managers can use this model to evaluate the sustainability standards of their current planning function. It is evident, from the prior discussion, that each measure (or practice) in the model is an operational guideline and can also be used to develop a future roadmap for the planning function incorporating societal welfare and environmental preservation.

The SPIng model can help the firms to identify the initiatives that might be easier to implement in the short term in order to quickly enhance efficiency and productivity. Subsequently, these can also be used to get the buy-in of higher management and other corporate functions such as Sales, Marketing and HR (Carter and Rogers 2008) for long term support. Since sustainability requires a broader approach, the firm and business level objectives must be aligned with supply chain objectives (Carter and Jennings 2002, 2004). In this context, the SPIng model can be extremely helpful as it presents a very clear, succinct and comprehensive picture of various broader areas (dimensions) and specific activities (operational measures), that can be further contextualized, to achieve not only regulatory compliance but also to make long term investment decisions keeping in view various organizational stakeholders.

The model can be validated through an empirical study. This model is part of an extensive, on-going Ph.D. study that is focused on the operationalization of sustainability in the supply chain of a focal firm. During the first stage of the study, high-level sustainability models were developed for procurement, transportation, manufacturing, warehousing and supply chain planning. These were then adapted for the food industry in Australia for empirical testing. Consequently, the measures in each model were translated into questions that are being used for data collection. This illustrates that the high-level sustainable planning dimensions and measures depicted in the SPIng model can be easily contextualized for various country, industry and business domains. Finally, the model can be used as a foundation for further theory construction in the domain of sustainable supply chain management.

References


