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Accounting towards sustainability in production and supply chains

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ABSTRACT

Growing interest in sustainability and corporate supply chains accompanies increased globalisation across developed and developing countries, a stronger focus on the logistics of procurement behind international trade, and information flows between parties about corporate economic, social and environmental performance. Accounting provides information to oil the wheels of supply chain relationships. The purpose of this paper is to consider what an accounting for sustainability of production and supply chains might look like. An overview is provided of the issues associated with a broadening of accounting needed for sustainable supply chains. The paper highlights: ongoing problems of scope and terminology, lack of a broad sustainability focus because of complexity which stunts the impact on decision makers, and the need for transdisciplinary teams to increase connectedness and performance of the supply chain. The need for further research relating to three issues is identified. First, who undertakes the accounting for supply chains; second, why should a business function account for supply chain involvement; and, third, what information is relevant to different functional managers?

1. Introduction

Globalisation is changing the settings for business thereby challenging management to move beyond conventional legalistic structures and into supply chains and the relationships between parties involved. Accounting has to address the complexities of a supply chain as an entity, which includes the focal organisation, suppliers upstream and purchasers downstream. Accounting, as a consequence, needs to change. It needs to reach beyond the legal corporate scope if it wishes to retain its relevance. As supply chain relationships are hedged about with uncertainty and complexity (Beckmann, Hielscher, & Pies, 2014) accounting has to provide decision support for managers in uncertain, globalised, logistics orientated, new communications settings required for effective supply chain management.

This paper aims to examine the potential function of accounting as a catalyst moving organisations towards sustainability in production and supply chains beyond the conventional corporate scope with the intention of assessing whether and how accounting might assist companies keen to engage. Section 2 briefly outlines the scope of supply chain management. Section

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3 examines what is envisaged by accounting for production and supply chains. It traces developments of ideas which have moved towards such an accounting. Section 4 addresses institutional considerations which make accounting for sustainable supply chains of growing significance. Section 5 considers how best to encourage accounting for sustainability of production and supply chains. Section 6 on the accounting/reporting nexus then leads to conclusions and future directions.

2. Scope of sustainable supply chain management and accounting

Challenges presented by the global reach of supply chains are a well-recognised target for current and future research and need to take account of the borders between inter- and intra-firm realities (Wood & Budhwar, 2014). Different notions of a supply chain exist in previous research, for example, Wiengarten, Humphries, McKittrick, and Fynes (2013) adopt an *inter-organisational* context for their study of information technologies such as the internet, which support electronic (e)-business spanning organisational boundaries within the German automotive industry. Research such as Wynarczyk (2013) and Harms and Klewitz (2013) include *extra-organisational*, secondary, or indirect contexts as part of the supply chain when they include universities, laboratories, governments, non-government organizations and local communities. Furthermore, an *intra-organisational* context is adopted by Bhattacharya, Mohatatra, Kumar, Dey, Brady, Tiwari, and Nudurupati (2013) who are concerned with how to measure green performance in supply chains in a collaborative setting. Finally, a focus on *internal company supply chains* shows most prominently that a distinction between *production process chains* and supply chains is often arbitrary. These different views of supply chains are strongly interlinked and require a broader understanding of measurement and management if performance improvement is to be achieved and contributions to sustainable development created.

Min and Kim (2012) view the lack of agreement over scope and definition of supply chain management as desirable because the concept's youthfulness means that as it matures it will be able to adapt to meet new ideas and practices. Recent literature has started to address sustainable supply chain management ideas and practices (Shi, Koh, Baldwin, & Cucchiella, 2012) which aim at integrating environmental and social issues (Seuring & Müller, 2008). Accounting for these issues is needed if trust between parties in the supply chain is to build.

The path to (corporate) sustainability accounting for supply chains is not well defined or bounded. At present the path is restricted because of scoping and definitional issues. But the information provided raises the possibility of supporting movement to better future states for society and the environment if informed mind sets about business can be understood and improved supply chain management and accounting practices encouraged (Burritt & Schaltegger, 2010; Schaltegger & Burritt, 2005).

3. What is envisaged by an accounting for sustainability of production and supply chains?

Difficulties emerge because the meaning of accounting, sustainability and supply chain are subject to different interpretations.

3.1. From financial to sustainability focus

Sustainability within supply chains involves management of environmental, social and economic relationships and organisational functions which affect performance of supply chain parties (Carter & Rogers, 2008; Lamberton, 2005). The definition of whether a company can be *sustainable* remains highly contested (Gray, 2010) and as a result the notion of corporate sustainability accounting is challenged. In part, the difficulty results from complexity – the simultaneous interactivity of multiple variables measured in different units, by different methods, at different times, for different periods, and in different entities (Stonebraker, Goldhar, & Nassos, 2009). Accountants and accounting helping to move companies towards sustainability was suggested by Schaltegger and Burritt (2000) as a pragmatic solution towards achieving sustainability goals.

One way forward is by enlarging the accounting scope step by step as for example by encouraging measurement and pursuit of eco-efficiency by companies and then to further broaden the scope towards sustainability. Given the complexity of sustainable development such a pragmatic approach may be the only way forward (e.g. Baker & Schaltegger, 2015). In principle the development of focused accounting approaches to consider a broader range of sustainability issues has been observed for a range of pioneer companies (e.g. Schaltegger & Wagner, 2006) and has been documented in various case studies (e.g. Herzig, Viere, Schaltegger, & Burritt, 2012). However, a narrow focus provides an incomplete picture and there is no guarantee that such a focus will always serve as a starting point for a more encompassing accounting, but it may in various cases lead to the desired broadening of the scope. The effect of a narrow focus on partial accounts of sustainability such as eco-efficiency accounts may mean further aspects of corporate sustainability escape management attention. Managers may not then realize the need for development of a more encompassing accounting scope of performances. A core challenge for research and practice is thus to find approaches to support an ongoing development of accounting for improved sustainability contributions.

Sustainability accounting needs to address the strategic integration of all three perspectives of sustainability, social, environmental and economic, for the company and in this case for supply chains (see Varsei, Soosay, Fahimnia, & Sarkis, 2014; Wang & Sarkis, 2013). However, in current mainstream corporate practice, as Vasileiou and Morris (2006) observe for 240 growers, 17 merchants, and 4 retailers in the potato supply chain in Britain, the dominant supply chain concern for business is

developing capabilities to ensure economic survival. This is similar to early work on environmental issues in supply chain management (Seuring & Goldbach, 2002). KPMG (2014) concur in their survey of large manufacturing organisations where cost reduction is seen as the critical supply chain issue and social capital is of lesser significance. Vasileiou and Morris (2006, p. 325) as a result of their research conclude in favour of the need for supply chain accounting, "objective, verifiable measures of sustainability are required to guide and report supply chain performance" and it is suggested by Beske and Seuring (2014) this requires the collaboration of all parties to the supply chain, something which KPMG (2014) indicate is still missing even in large multinational companies.

The last decade has seen attempts at conceptual expansion to include ethics and governance in sustainability as proposed by Beckmann et al. (2014) who argue that trade-offs between social, environmental and economic sustainability aspects at the operational level can be transformed to strategic win–win situations through innovation. While trade-offs in sustainability contexts are sometimes emphasised (Hahn, Figge, Pinske, & Preuss, 2010) the aim of a pragmatically informed sustainability accounting particularly in a complex supply chain management context of collaborating with various tiers of suppliers can only be to support management to overcome trade-offs or to create win situations for all stakeholders involved (Baker & Schaltegger, 2015; Burritt & Schaltegger, 2010). It is acknowledged that this may be difficult and in some cases impossible in the short run but often collaboration with stakeholders in the supply chain may help towards finding innovative solutions (Harms & Klewitz, 2013). The conceptual debate about sustainability continues, while practice lags. However, economic progress, social development and environmental improvement and their integration by corporations are what need to be accounted for in sustainable supply chain accounting.

Challenges of sustainability in supply chains are succinctly outlined in a study of a Dow chemicals business by Zhang, Shah, Wassick, Helling, and van Egerschot (2014). A holistic approach to cost optimization over the entire supply chain provides the foundation before sustainability considerations are added. Unfortunately, complexity seems inevitable in these settings where practitioners would like simple rules of thumb.

The most critical problems facing humanity today are complex sustainability problems, such as climate change, characterised by high levels of uncertainty, multiple perspectives and multiple interlinked processes from local to global scales (Apgar, Argumedo, & Allen, 2009). For successful resolution to emerge complex problems usually require more than one perspective and inter- and transdisciplinary approaches to management (Schaltegger, Beckmann, & Hansen, 2013). For example, carbon accounting as a foundation tool for understanding climate change impacts requires the expertise of farmers, accountants and assurance providers, engineers, policy makers, natural scientists, etc. The suggested way to address such complexity is through transdisciplinary teams. Apgar et al. (2009, p. 3) comment: "Such approaches are less about producing high quality specialised knowledge that can be used to solve a 'problem', and more about bringing different knowledge systems and people together to improve a complex situation". Carbon accounting teams are seen as enablers of solutions to the complex problems of climate change facing business and society (Ascui & Lovell, 2011) through the bringing together of these different frames of reference, but the problem becomes far too complex once extra-organisational supply chain networks are contemplated.

In contrast, Stonebraker et al. (2009), given organisational and behavioural causes of supply chain vulnerability, apply an easy-to-implement diagnostic process to address the potentially disastrous consequences of supply chain disruption. They develop a flexible and adaptable integrated model and internal business accounting system for organizing and managing the data gathering and analysis of cost and fragility of supply chains, but their study is an exception.

To capture the complexity of sustainability multidimensional indicator and assessment systems have been proposed. Varsei et al. (2014) develop such an approach for sustainable supply chain management. Whereas there is no doubt that such approaches are needed if undesired trade-offs are to be avoided it is important to secure practicability of measurement, assessment and indicator approaches (Bai & Sarkis, 2014a). Zhang et al. (2014) seem trapped in complexity of their own making with multi-objective maximisation in a Pareto optimal setting and large scale supply chains. The result based on the actual data available, which only considers greenhouse gases, total costs and lead times, and not social issues, is that a considerable decrease in greenhouse gas emissions or lead time can be achieved by a small increase in cost in the single period examined. However, unrealistic economic assumptions are used such as a constant cost of raw materials purchases, emissions from selected processes and suppliers are not considered because of a lack of accurate data and "we obtain an MILP with 533,093 continuous variables, 529,970 binary variables, and 1,125,966 constraints" (Zhang et al., 2014, p. 75). Likewise, Longinidis and Georgiadis (2014) bring complex mathematical models and financials into supply chain network management, once again with real data from a European consumer goods company. Practitioners will find implementation of such models very difficult and the move to accounting for sustainability of supply chains thwarted.

3.2. From accounting to sustainability accounting

The meaning of accounting has been confronted since Elkington (1998) drew attention to the need to consider environmental and social impacts and performance of companies with broader scope and in a more encompassing way. Accounting comes in several shapes and sizes and is orientated towards the purpose of the recipients (Schaltegger & Burritt, 2000). Financial accounting provides a foundation for external financial reporting disclosures and accountability and is largely directed towards the purpose of increasing company profitability, subject to risk, liquidity and solvency considerations. Management accounting provides data for decisions made by managers wishing to plan and control the company,

communicate about and coordinate company activities, motivate desired behaviour of employees and lead the business to success through innovation and learning.

Elkington's (1998) triple bottom line challenge to financial accounting has been taken up by groups wishing either to expand the indicators of corporate performance through sustainability accounting and reporting (e.g. the Global Reporting Initiative, United Nations Global Compact, Integrated Reporting, and Greenhouse Gas Protocol), or to incorporate additional social and environmental considerations in financial reports. In addition accounting for the interrelationships between different sustainability perspectives, environmental, social, governance, etc., has been called for (Milne, 1996; Schaltegger, Bennett, & Burritt, 2006). Although an encompassing consideration of sustainability perspectives and interrelationships is rarely considered in practice some approaches such as accounting for eco-efficiency (e.g. Callens & Tyteca, 1999; Schaltegger, 1998; von Weizsäcker, Hargroves, Smith, Desha, & Stasinopoulos, 2009), measuring shareholder value creation through environmental measures (e.g. Hillman & Keim, 2001; Schaltegger & Figge, 2000), etc. have been proposed as partial linkages.

Apart from enlargement from the financial scope of accounting to the triple bottom line sustainability also calls for an enlargement of the geographical scope beyond legal corporate boundaries. Seal, Cullen, Dunlop, Berry, and Ahmed (1999) and Ramos (2004) recognise that supply chains and supply chain management were not well considered by management accounting, and Seuring and Müller (2008) advance the area through accounting and management control for sustainable supply chain management.

Research acknowledges the increasing complexity which goes along with the environmental, social and geographical scopes and has tended to focus on environmental aspects such as environmental management accounting (Burritt, Hahn, & Schaltegger, 2002; Schaltegger, Gibassier, & Zvezdov, 2013), carbon management accounting (Ascui & Lovell, 2011, 2012; Burritt, Schaltegger, & Zvezdov, 2011) and more recently water management accounting (Signori & Bodino, 2013).

While some progress exists in sustainability accounting practice (Bennett, Schaltegger & Zvezdov, 2013; KPMG, 2014) it is predominantly large corporations and not small companies experimenting while applying a narrow geographical focus on the focal company. Exceptions are Herzig et al. (2012) for small and medium sized (SME) companies in developing countries and Clarke-Sather, Hutchins, Zhang, Gershenson, and Sutherland (2011) for SME and sustainable supply chain accounting. In general, however, accounting for sustainability of supply chains remains a greenfield with little well founded theoretical literature or good practice to draw upon for exemplars.

3.3. From internal production processes to production in supply chains

To grasp the potential of accounting for sustainability of production and supply chains it is also necessary to understand the essence of a supply chain and sustainable supply chain management. Both are dogged with terminological issues.

The basic definition of a *supply chain* is uncontroversial. Mentzner et al. (2001, p. 4), following a review of available literature, provide a simple but pragmatic definition of a supply chain as being "… a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer". Three generic entities involved in a supply chain are the supplier, the producer (or the focal organisation) and the customer (Christ, 2014). Taken literally, production is a major activity of manufacturers who obtain raw materials or semi-finished goods and turn them into an intermediate or final product which can be sold; but in a broader definition it also refers to services produced by organisations as the factors of production, land, labour, capital and entrepreneurship are gathered and converted to a product and sold. Cost and management accounting conventionally provide the accounts for manufacturing organisations. Further, in some industries like the fashion or sports apparel industry, the intangible value of the brand may even extend the value of the actual material product and be considered the key producer of economic value. Accounting for supply chains has to consider the information involved with these various independent parties often linked by agreement working together, sometimes across multiple supply chains.

There is discretion in the number of parties identified as being engaged in the supply chain process and for which accounting is required. A life cycle analysis could produce an infinite regress of parties. A way of restricting the number of parties is to scan all supply chains and to conduct a simple hot spot analysis based on literature and tacit knowledge of experts. The development from accounting for a limited number of identified hot spot supply chain parties to a more encompassing sustainable supply management accounting has been observed for a range of pioneer companies (see e.g. Sarac, Absi, & Dauzère-Pérès, 2010 who mention the Food & Drug Administration, Mark and Spencer, Tesco, Gillette). However, the approach developed is mostly impractical in contexts having many suppliers and complex supply chains.

Gualandris et al. (2014) conclude from an empirical analysis of assembly manufacturing companies from 21 countries that sustainable supply chain management improved the environmental and social performance of the focal companies. In contrast, Ortas, Moneva, and Álvarez (2014) considering economic performance find a unidirectional link between firms' profitability and sustainable supply chain performance in an empirical study of 3900 companies over eight years (2004–2011). Survival could mean that one party in the supply chain sees an economic loss while the others see a gain, but the whole chain may collapse if the parties do not trade gains whether from improved operational performance (Lambert & Pohlen, 2001) or improved information exchange (Ramdas & Spekman, 2000). The issue is how to account for the net gains or losses from supply chain arrangements distributed between the participants (Shank & Govindarajan, 1992). Clearly negotiation between the parties in the supply chain is needed to share the gains from a potential investment.

The function of accounting is to provide information which helps with the determination and sharing of gains from supply chains, subject to the difficult issue of scope of parties included.

3.4. Supply chain management and sustainable supply chains

As a minimum, the notion of management presupposes two things: a subject that manages (e.g. a single manager of a small business company or a group of managers) and an 'object' that is to be managed (e.g. the whole business company, production department, or in this case the supply chain) (Schaltegger, Burritt, & Petersen, 2003). Although the components of a simple supply chain are easy to comprehend there is no consensus over a definition of supply chain management as authors talk variously about a process, a discipline, a philosophy, a governance structure, or a functional area (Ellram & Cooper, 2014).

The word 'management' is used here to refer to the functional areas being managed and the associated roles of managers. Hence, supply chain management can be interpreted in relation to functions such as research and development, procurement, supplier management, logistics, production, and accounting for sustainability. A sustainable supply chain manager manages the supply chain relationships and functions towards sustainability outcomes and with implicit or explicit supply chain management strategies (Harms, Hansen, & Schaltegger, 2013; Seuring & Müller, 2008), usually through much favoured collaboration (Gulati, Lavie, & Singh, 2009; but see Dillard & Roslender, 2011).

Beske and Seuring (2014) identify five key categories which are of high importance for sustainability management of supply chains: orientation toward supply chain management and sustainability, continuity, collaboration, risk management and proactivity. Essential elements of a sustainable supply chain to be managed and for which accounting is required are suggested by Gopalakrishnan, Yusuf, Musa, Abubakar, and Ambursa (2012) in the context of a literature review and their study of British Aerospace systems. A ten point guide to best practice for the deployment of sustainability in supply chains is derived. Accounting is not specifically mentioned but is implicit in the final point that for control of the other nine supply chain sustainability considerations Key Performance Indicators (KPIs) need to be identified and ranked according to priority based on management's perception of the challenges. For example, emphasis in supplier selection is on the importance of auditing of supplier environmental performance, health and safety, reduction of waste and packaging material, use of carbon efficient logistics transport, etc. Each KPI needs to be benchmarked (Colicchia, Melacini, & Perotti, 2011) and results compared over time.

From a pragmatic perspective on sustainability accounting, identification of key sustainability issues (Baker & Schaltegger, 2015) and the choice of a set of adequate tools is required to assist managers with responsibility for achieving purposive sustainability goals in their companies (Burritt & Schaltegger, 2010). This includes a specification of what sustainability performance entails in the context of the organization, its business environment and social setting. Such specification will in many cases lead to a focus on a number of prioritized aspects of sustainability (such as eco-efficiency of production, health and working conditions in the supply chain, etc.) which, if individually improved, will improve overall sustainability performance. Based on the identification of key sustainability issues the requirements and management accounting tools for which data need to be gathered, classified, accumulated and used in different decision settings can be specified. Skill sets of accountants need to be developed in order that they can build beyond conventional accounting to address sustainability issues. An inside-out approach to developing sustainability accounting tools and processes first identifies KPIs from corporate and business strategies and second builds management support systems founded in the sustainability accounting system (Burritt & Schaltegger, 2010; Schaltegger & Wagner, 2006). The complementary outside-in approach raises the pragmatic problem of how to identify opportunities and risks, and establish sustainability policies, sustainability accounting and standardised reporting and assurance from an outsider's perspective. Sustainability accounting in practice requires an inside-out and an outside-in perspective, a twin-track approach. One unifying foundation suggested is through eco-control (Henri & Journeault, 2010; Schaltegger & Sturm, 1996) as a number of factors affecting company environmental performance (regulatory compliance, process and product improvements, innovations, financial impacts and stakeholder relations) mediate between eco-control and economic performance, but a similar set of factors are yet to be revealed in the literature for integrated sustainability-control which would form part of management accounting.

3.5. Supply chains and supply networks

Further confusion in the notion of accounting for production and supply chains arises because research about supply chain management has been divided between supply chains and supply networks. Practitioners have preferred to emphasise the key processes of supply chains, with collaboration between parties being the most important (Gibson, Mentzer, & Cook, 2005). Braziotis, Bourlakis, Rogers, and Tannock (2013, p. 648) view the essence of supply chains as being "… a set of primarily collaborative activities and relationships that link companies in the value-creation process, in order to provide the final customer with the appropriate value mix of products and/or services." The key focus of the supply chain is seen as collaboration for value creation rather than conflict (Gold, Seuring, & Beske, 2010). In contrast, dominant academic literature about (conventional) supply chain management is claimed to favour a holistic strategic focus including links to other management techniques such as Just in Time, Total Quality Management and Electronic Data Interchange, target costing and outsourcing (Albright & Davis, 1999). Emphasis is placed on these management and accounting techniques.

Collaboration, innovation and monitoring of social issues in supply chains are examined by Klassen and Vereecke (2012) through interviews within multinationals in Europe. Accounting is involved in the monitoring of performance with one aspect being supply chain costs, but it is acknowledged that pathways to competitive benefits are 'fuzzy' and although assurance is growing development of metrics remains under researched (Klassen & Vereecke, 2012, p. 114).

In contrast, supply networks are seen in terms of relationships between "… a set of active members within an organisation's supply chains, as well as inactive members to which an organisation relates, that can be called upon to actively

contribute to a supply chain if a need arises " (Braziotis et al., 2013, p. 648). Emphasis on the identification of and interrelationships between supply chain members and their salience, whether active or inactive participants, is a notion similar to the focus of Mitchell, Agle, and Wood's (1997) view of stakeholder theory. Emphasis is on accounting for the social relationships between parties.

Lack of visibility of extended supply chain relationships continues to be seen as of major importance to executives in manufacturing companies (KPMG, 2014), with inadequate IT systems and lack of skilled talent to manage supply chain visibility being cited as the two main causes. Three-quarters of 460 respondents to a survey of large manufacturers say that their relationship with top-tier suppliers is now strong enough for them to share real-time capacity and demand data (KPMG, 2014, p. 21) thereby establishing the foundation to move from supply chain to supply network relationships and build supply network accounting.

In summary, understanding of terms in the sustainability accounting for supply chain space is hedged about with the complexity of sustainability perspectives, broadened geographical scopes and confusion which accompanies new administrative technologies, with changes to be expected over time as the dynamics of sustainable supply chain management mature. Accounting for sustainability in supply chains can be organised in a systematic way by: considering corporations as suppliers, focal organisations and customers with a concern for information that helps towards collaboration for survival and progress; looking for a focus on economic, social and environmental impacts of organisations and their integration; and emphasising value of the supply chain and how best it contributes to the value to the businesses involved.

Certain institutional developments have fostered the interest in accounting for sustainability in corporate supply chains and these are examined next.

4. Institutional developments

There has been a growing tendency for research and practice to focus on accounting for sustainability of production and supply chains as environmental and social issues and their management become increasingly significant to the future value of businesses keen to obtain a competitive advantage, to ensure competitive survival, or to grasp opportunities and control risks (Burritt, Schaltegger, Bennett, Pohjola, & Csutora, 2011). In addition to economic drivers a growing group of academics and practitioners is motivated to search for approaches to create sustainable development. This is also reflected in the definition of corporate sustainability as an approach to improve the sustainability of an organisation and to create contributions to sustainable development of markets and society at large (Schaltegger & Burritt, 2005) and which requires the consideration of supply chains. An indication of growing popularity of sustainable supply chain management is signalled by fifty two million hits for the search term 'Sustainable Supply Chain' (on Google) (790,000 on Google Scholar); 44 million for 'Sustainable Supply Chain Management' (620,000); 19.7 million for 'Sustainable Supply Chain Accounting' (180,000); and 3.2 million for 'Sustainable Supply Chain Management Accounting' (115,000) at 1st July 2014.

Literature on sustainable supply chain management has increased exponentially in recent years as wider recognition is given to implications for businesses of: globalization, cost-effective logistics processes, information systems which shrink geographical proximity of parties, and integration of the different dimensions of sustainability (Burritt, Schaltegger, Bennett, et al., 2011; Seuring & Müller, 2008). The growing interest in accounting for sustainability of supply chains accompanies these institutional developments.

4.1. Globalization and regionalisation

Goods and services are being produced in and acquired from different countries triggered by growing international trade in order for companies to capture lower costs and efficiencies from operations or associations across national boundaries. The economic advantages of globalization are at stake if the undesired environmental and social effects of longer, more separated and geographically spread supply chains are not reduced substantially. Given that poverty is extreme in developing countries and that global supply chains in many industries largely operate within the developing country nexus it was a logical step to begin to focus policy attention on improving corporate sustainable supply chain management to assist with the social issue of poverty reduction (WCED, 1987).

With the need to reduce global poverty as a prior assumption a further complexity associated with accounting for sustainability of supply chains is choice of the level at which analysis occurs (De Castro, Khavul, & Bruton, 2014). For example in relation to accounting for water supply issues the potential problems of water scarcity may be viewed by company management, catchment management, or policy makers at the state level. While much emphasis is placed on the importance of addressing multiple perspectives on sustainability issues, at macro, meso and micro levels Foxon (2011) argues for a coevolutionary approach. Hence, accounting for sustainability of supply chains could address these multiple scales in a pragmatic way which supports management decision making in the sustainability and business context.

4.2. Logistics

Logistics structures for international trade need to drive cleaner production and processes that are innately safe, secure and compliant with norms which respect fundamental human rights and environmental sustainability. Transportation of products, both intermediate and final, was not an issue for the majority of companies, when production and sale took place

locally, as suppliers and purchasers were located in close proximity to each other. Global logistics management has developed to recognize all the material, service, information and capital flow activities associated with transactions, transformations and external events of companies in the cross border supply chains. Such chains facilitate the purchase of raw materials in resource rich mostly developing countries, the production of goods in emerging, newly industrialized and developing countries (e.g. Brasil, Russia, India, China, Malaysia), purchase of goods by consumers in developed and emerging economies, and recycling of finished products. Accounting for sustainability aspects of logistics presents a major challenge for the future.

4.3. Tracking, communications and reporting

Shrinking geographical proximity facilitated by cost-efficient communication mechanisms is speeding the tracking and flow of information that parallels the transfer of production materials, intermediate and final products and services between different parties in different countries, as well as assists parties to track and report actions of companies in a fast and responsive manner. Accounting in the context of new technologies and open communications between organisations and across borders is needed to reflect the changing context of data, information and knowledge development and transfer.

4.4. Integration

Companies can move to secure advantages from activities which encourage sustainability by addressing environmental, social and economic issues in an integrated manner (Boyd, Spekman, Kamauff, & Werhane, 2007; Carter & Rogers, 2008). They can also secure advantages by recognising that investment in improving social and environmental performance does not have to come at the expense of economic performance (Beckmann et al., 2014; Schaltegger & Synnestvedt, 2002). The interrelationships and trade-offs between dimensions of sustainability are a vitally important part of sustainable supply chain management (Hahn, Figge, Pinkse, & Preuss, 2010) because sacrifices in one dimension can lead to larger than proportionate gains in other dimensions throughout the sustainable supply chain. Accounting for such interrelationships and trade-offs represents the main focus and *bête noire* of corporate accounting for unsustainability (Schaltegger & Csutora, 2012). The overall focus and aim of a pragmatically informed accounting for sustainability remains to identify and realize triple-win potentials (Baker & Schaltegger, 2015; Burritt & Schaltegger, 2010).

The need for development of accounting for sustainability aspects of supply chains, the viability of identified win–win approaches to overcome trade-offs and of contributions to sustainable development is increasing in significance because of this range of contextual considerations promoting sustainable supply chain management as a potential benefit for business.

5. How can accounting for sustainability of production and supply chains best be encouraged?

Conventional accounting is largely about identifying and recording inter-company data from external market transactions, intra-company internal transformations, and some external events (inflation being a notable exception) (Chambers, 1966). Sustainable supply chain management, however, largely looks at intra-supply chain processes and transactions, transformations and events, including non-market interactions (Schalteger & Burritt, 2014). Accounting external to the supply chain is little considered but in principle could address inter-supply chain data from external market transactions, intra-supply chain transformations, and some events external to supply chains. When there is a preponderance of vertical integration (e.g. cradle to gate thinking for sustainability within a company) then few supply chain settings arise. However, when different functions, products or services are provided from outside the organisation, e.g. external supply rather than internal supply of goods and services, then accounting for the supply chain has the potential to add value. The following sub-sections discuss the potential of a set of existing systems for accounting for sustainability in production and supply chains.

5.1. Environmental accounting

Corporate environmental accounting was introduced to enable managers to focus on impacts of the environment on business performance and impacts of the business on the environment (Schaltegger & Burritt, 2000). Within environmental accounting environmental impacts and costs are identified and assessed in terms of their significance as part of the cost structure of the business. Costs of raw material supplies are regarded as business as usual, as inputs to a production or service process which are often seen as unexpectedly high (Ditz, Ranganathan, & Banks, 1995). Different cost classifications are introduced in environmental accounting with the cost of building and maintaining links with environmental costs of suppliers being classed as “less tangible”, “relationship” or “image” costs (US EPA, 1995, p. 37). Sometimes up to 40% of total costs could be identified as environmental and in need of closer management. Accounting data is needed in order to enable such management but there is little focus on issues of supply within the environmental accounting literature.

5.2. Environmental management accounting

Information guiding corporate environmental-economic decisions made by managers was a key aspect of the development of a comprehensive conceptual framework for environmental management accounting developed by Burritt et al. (2002). Environmental management accounting draws attention to the importance of monetary and physical data for

decision making and control (Jalaludin, Sulaiman, & Ahmed, 2011). It suffers from and needs to address all of the problems associated with conventional management accounting (Burritt, 2004): arbitrary cost allocation; narrow and short term performance appraisal techniques; lack of attention to articulation of stocks and flows; a narrow focus on manufacturing; dominant financial accounting rules for inventory measures; and, absence of accounting for externalities.

In its favour environmental management accounting considers the underlying notion of seeking business opportunities for "strong eco-efficiency" whereby the environment and monetary performance of companies are both improved, or at least do not deteriorate when decisions about the environment are made (Schaltegger, 1998; Schaltegger & Burritt, 2000). In addition it recognises the nature of information for decision making varies with: (1) the type of decision to be made e.g. environmental or economic, (2) the context and time horizon of the decision e.g. short or long term, (3) the stakeholders involved and their sensitivity to environmental issues, e.g. environmental managers steeped in engineering knowledge or chief financial officers with a background in accounting, (4) the type and size of firm, e.g. large multinational or small local, (5) the sector e.g. manufacturing or services, and (6) the regulatory environment, e.g. voluntary selection, adoption and implementation of tools rather than regulated by government (Foran, Lenzen, Dey, & Bilek, 2005; Olsthoorn, Tyteca, Wehrmeyer, & Wagner, 2001). Environmental management accounting places especial emphasis on the efficient use of resources and the minimisation of non-product output – e.g. wasted minerals resources (Jasch, 2009) – to preserve them for future generations of people (Ván & Gärtner, 2011) and in principle could be applied to supply chains.

Supplier selection is one of the main issues in supply chain management and greater sophistication is emerging in the methods being promoted to address supply chain interrelationships but little research has been conducted into accounting and sustainability issues associated with supplier selection. Govindan, Khodaverdi, and Jafarian (2013) address the issue with a fuzzy multi criteria mathematical programming approach. Multiple criteria for decision making are a definitional aspect of sustainability with economic, environmental and social matters being considered. The criteria are fuzzy because the sets to which information belongs (e.g. environmental or social) are based on language and consequently are overlapping, imprecise or incomplete (Tsai & Hung, 2009). Govindan et al. (2013) identify key information to derive a simultaneous choice in supplier selection decisions: economic (cost, delivery reliability, quality, technology capability), environmental (pollution, resource consumption, eco-design, environmental management systems), and social (employment practices, health and safety, influence of local community and contractors). While accounting for each of these dimensions may be possible the complexity of these operational research techniques can lead to a low take up in practice. The challenge is taken further in environmental management accounting by Chan, Wang, and Ruffoni (2014) in the context of reducing development lead times for different product designs.

Given the contextual aspects in which accounting for sustainability of production and supply chains operates there is a tendency in sustainable supply chain research to step back from the complexity of sustainability issues and focus on parts – social or environmental and their connection with the economic rather than on sustainability which is more complex (see Lee & Wu, 2014; Chan et al., 2014). Research into sustainable supply chains initially involved a focus on building environmental aspects into conventional internal company functions such as green logistics and purchasing from suppliers, green design and investment in production facilities, green marketing to consumers, and green waste management such as closed-loop end of life recycling environmental management practices (Srivastava, 2007).

Four of the most common tools used in environmental management accounting are material and energy flow accounting and environmental flow cost accounting, and physical environmental investment appraisal and monetary environmental investment appraisal (Burritt et al., 2002). Klassen and Vachon (2003) examined the link between supply chain collaboration (site visits, technical exchanges, etc.) and evaluation (assessing performance, providing feedback, confirming supplier certification) of monetary environmental investment and the potential to shift investment from pollution control towards pollution prevention. Such investment has been encouraged by polluter pays principles of sustainable development and was examined for a set of manufacturing plants across industries in Canada. Results indicated that collaboration was positively related to investment in pollution prevention technologies whereas quite surprisingly for accounting upstream monitoring and assessment (evaluation) of suppliers was not.

Further studies have involved investment in suppliers by the focal organisation downstream. They culminate in studies such as Bai and Sarkis (2014b) and Chan et al. (2014) supplier selection with comprehensive evaluation of investment in green product process or organizational technologies under fuzziness in supply chains.

Moving from environmental to social management accounting has yet to occur.

5.3. Activity based costing

Conventional intra-firm cost accounting tools have many problems (Burritt, 2004) and are also seen as inappropriate in the supply chain context (Schulze, Seuring, & Ewering, 2012). With a range of activity based costing systems having been proposed these were examined by Schulze et al. (2012) and an activity based costing framework developed as a way to assess inter-firm cost savings in a supply chain. Given a dearth of prior literature on how to deal with, calculate and distribute costs in inter-firm settings, the authors examined an actual activity based cost accounting system using an exploratory case study of a three tier supply chain in one of the world's largest leading manufacturers for facade construction components (e.g. windows, doors, solar modules, conservatories). Results indicated practice uses a partial system based on dyadic relationships, e.g. between the supplier and focal organisation, rather than an encompassing analysis of supply chain costs and cost savings. The main reason discovered for the simplified approach is the complexity associated with data standardisation

between the parties, acquisition and processing of data which leads to effective 'prohibiting' of data exchange amongst parties (Schulze et al., 2012, p. 716).

As there are no standards for costs in such settings the implication is that they need to be developed. Also activity based costing can be seen as overly complex. The implication is that, particularly in the exchange with small and medium sized suppliers in many different countries, a simpler costing system in the collaborative setting examined would be more effective for overall supply chain performance in relation to some processes such as reduction of total order costs, and inventory reduction. The authors recognise that the *global* setting adds complexity which will affect accounting as the supply chain parties often extend to the supplier, several logistics service providers, the manufacturer, the retail sector and the final customer. They see that *integration* of the supply chain parties (van der Vaart & Van Donk, 2004) requires a common set of cost accounting standards with the cost of *logistics* for the total supply chain being calculated based on a joint definition of activities and their cost drivers leading to the aggregation of supply chain activity based costs (Dekker & van Goor, 2000).

Activity based costing, with its attempt to assign rather than allocate costs to activities and then to units of output, lost its glamour in the 1990's (Gosselin, 1997). Evidence in a Canadian study by Gosselin (1997) indicated adoption did not lead to implementation even in centralized, bureaucratic organisations which seemed to favour the approach. Implementation by smaller companies and non-manufacturing companies in a sample of New Zealand companies faced the greatest hurdles (Askarany, Yazdifar, & Askary, 2010). Processing costs required to develop the drivers of activities seemed to be greater than benefits, the system popular with consultants used considerable resources and value to the company often did not materialise. Hence, the foundation of accounting for supply chains on activity based costing seems fraught with difficulties.

Process costing is one aspect of activity based costing which remains current in two ways. Firstly, activity based costing selects a multiple set of cost drivers the costs from which are to be linked to product cost. Processes such as the Analytical Hierarchy Process and multi objective programming are used as a way to optimize selection of the cost drivers (Schniederjans & Garvin, 1997). Chan et al. (2014) provide the latest thinking by suggesting a fuzzy Analytical Hierarchical Process in a supply chain setting for choosing the green design of a product. Design is argued to be where costs and environmental performance are locked in. Secondly, accounting for material, energy, water and waste flow processes also forms part of material flow cost accounting (see next sub-section). Data from production processes and supply chain actors is gathered by process technicians and fed into the accounting system (Jasch, 2003). Processing cost of non-product output is important data in the justification for material flow cost accounting, for which a new international standard, ISO 14051, has recently been developed.

5.4. Material flow cost accounting

Material flow cost accounting has received publicity since the recent release of a new standard by the International Organization for Standardisation, ISO 14051. The standard explicitly recognises links between MFCA and supply chain partners (ISO, 2011). Material flows map movements into, within and out of organisations, or in the case of a supply chain, through the chain.

The concept behind material flow cost accounting is that non-product output embodies waste which careful process tracking can help to eliminate thereby helping the environment and saving companies or supply chains material costs. It was developed in the late 1990s under the name 'flow cost accounting' (Federal Environment Ministry and Federal Environment Agency, 2003). Empirical evidence, largely case based, is slowly becoming available about the technique and its application (Jasch, 2009, 2011). Material flow cost accounting methods have been extended to supply chain management (Jindrichovska & Purcărea, 2011; METI, 2007; Schrack & Prammer, 2013). One benefit of implementing material flow cost accounting in the supply chain is that the data provided can then be used to support life cycle assessment. Between 2008 and 2011 the Ministry for Economy, Trade and Industry in Japan organised a project examining the introduction of material flow cost accounting into 50 supply chains (Kokubu & Tachikawa, 2013; METI, 2007). But with studies finding: managers do not easily accept the concept in practice as they feel they are efficient in their material use already (e.g. Gale, 2006); difficulties with the confidentiality and the collection of data (Weigand & Elsas, 2013); and some cultures are less accepting than others (Deegan, 2007), it is too early to assess the future benefit of material flow cost accounting. Reviews of material flow cost accounting identify limited application in comparison to its potential application (Christ & Burritt, 2014; Schaltegger & Zvezdov, 2014).

Material Flow Cost Accounting is an environmental management accounting approach which supports an encompassing calculation of internal company costs of material throughputs of production, including many costs which with conventional accounting approaches are not specifically captured (e.g. Jasch, 2009; METI, 2007). A multitude of applications of material flow cost accounting show that non-product output production costs can be substantially reduced through the reduction of material flows identified with material flow cost accounting (e.g. Herzig et al., 2012; Schaltegger & Csutora, 2012). Furthermore, and usually not addressed in the material flow cost accounting literature, the use of materials in production is always preceded by a supply chain and accompanied by energy consumption and environmental impacts. Reducing the throughput of materials in production thus leads to reductions of material flows in the supply chain and can initiate substantial environmental improvements in many companies and countries.

Examining the scope of material flow cost accounting shows that both the methodological proposals in the research literature and applications are largely focused on production related decisions. Linking material flow cost accounting with environmental management accounting reveals potentials for expansion for methodological development and applications including supply chain accounting (Jasch, 2011; Jindrichovska & Purcărea, 2011; METI, 2007; Schrack & Prammer, 2013).

5.5. Carbon accounting and eco-control

Lee (2012) examines the relationship between eco-control, as an integral part of management accounting, and supply chains. Eco-control introduced and developed by Schaltegger and Sturm (1992, 1996), is defined more recently by Henri and Journeault (2010, p. 64) as "the formalized procedures and systems that use financial and ecological information to maintain or alter patterns in environmental activity". In plainspeak this means the formalised element of management control systems includes: budgeting, associated allocation of resources, performance reporting and evaluation and the incentives for employees to do what is best for the company (Thrane & Hald, 2006). Carbon accounting, a sub-set of environmental management accounting, is applied to supply chain issues by Lee (2012) who points to the need to measure Scope 1 (direct), 2 (indirect from energy sources) and 3 (often largely supply chain) carbon emissions, when there is a lack of suitable accounting tools for businesses. Based on the notion of eco-control in Korean automobile manufacturing with one supplier and two manufacturers, Lee (2012) identifies the practical usefulness of environmental management accounting as a tool to map and manage carbon risks and performance for the focal production companies and the upmarket supply chain. Carbon accounting is seen to be useful to quantify the environmental actions of the companies, respond to climate change, and integrate the key supply chain carbon concerns into the supply chain management processes. However, it is little used at this point and suffers from potential double counting.

Carbon accounting is examined from a conceptual perspective by Schaltegger and Csutora (2012). An important contribution in the current context is the recognition and examination of carbon accounting and carbon management accounting where areas unexplored are said to include amongst others the design of processes, measures and indicators to document all carbon emissions of a supply chain. With applicability to all sectors and their supply chains the authors consider two approaches: carbon accounts for unsustainability and carbon accounting for sustainability improvements. In relation to unsustainability the aim is for accounting to bring forth transparency about past impacts and to forecast future greenhouse gas emissions for decision making and control. For improvements, dynamic and enabling accounting procedures are needed in order to play useful roles in corporate carbon reduction. In addition, the link between carbon accounting and management decision making is examined. First, the notion of 'hidden' and invisible carbon emissions is raised as imported intermediate and final goods from suppliers may be uncontrolled (Schaltegger & Csutora, 2012, 3). Second, the global dimension of supply chains especially between developing and developed countries is to deal with the trend of substituting carbon emissions from production in developed countries to production in developing countries and in addition to deal with carbon emissions of increased transportation which calls for sustainable mobility. Third, is the emphasis on carbon neutrality of supply chain activities, or indeed overall carbon positive and the way accounting for efficiency improvement can assist as with Dole and their bananas and pineapples looking for solutions in terms of agricultural practices and transportation (Schaltegger & Csutora, 2012, p. 6). Finally, the link between carbon management accounting and carbon management control including supply chain control is established. This also includes benchmarking of carbon performance in supply chains (Acquaye, Genovese, Barrett, & Koh, 2014). Furthermore, to make progress, as empirical evidence gathered by Burritt and Tingey-Holyoak (2012) reveals, the links between academics and practitioners and dissemination of information are in need of attention for a dynamic accounting, including supply chains, to emerge.

Carbon footprinting has been suggested as an indicator tool which can be adapted to assess corporate environmental performance in physical terms (Hoffmann & Busch, 2008; for application in a specific industry see Penela, García-Negro, & Quesada, 2009; Rugani, Vázquez-Rowe, Benedetto, & Benetto, 2013). So-called carbon footprints are measures of greenhouse gases produced by activities and are usually expressed in equivalent tonnes of carbon dioxide (CO_2). They are measured as a carbon dioxide equivalent emission weight for any level of activity over a period of time for a particular entity e.g. tonnes of carbon dioxide emitted for a supply chain over a year. The aim for an entity made aware of its footprint is reduction on the basis that this will help reduce the identified problem of global warming. Many carbon calculators are readily available online for this purpose but have been criticised for their lack of consistent results and the need for transparency in their assumptions (Padgett, Steinemann, Clarke, & Vandenbergh, 2008). Integration of carbon emission concerns into operations relating to procurement, production, inventory management and their impact on costs in supply chains can contribute towards clean technology investment decisions (Benjaafar, Li, & Daskin, 2013). Lee (2012) points out, pragmatic environmental management accounting and eco-control tools developed for decision making about carbon emissions in the Korean automobile industry supply chain provide a useful case for better carbon management, but wider empirical evidence is needed. Large sample quantitative studies across supply chains in different industries are recommended. However, measurement issues remain a formidable obstacle to the development of reliable carbon footprint data for decision making. A snapshot of some such upstream and downstream issues is provided by Arzoumanidis et al. (2014) when examining accounting for biogenic exchanges in the wine industry. These include forest management, agricultural practices and land use, soil erosion, the inclusion of all parts of a tree, the inclusion of the end-of-life phase, etc. and require knowledge that goes well beyond that available to the conventional accountant.

5.6. Water management accounting and supply chain value added

Recognition of risks to business from extreme weather events causing water shortages or surpluses has grown considerably with water crises being ranked third amongst the ten global risks of highest concern in 2014 (Money, 2014; World Economic Forum, 2014). Water accounting has been growing in popularity.

Water management accounting is a further sub-set of environmental management accounting but with little attention in the literature on supply chains. However, Joa, Hottenroth, Jungmichel, and Schmidt (2014) recognise that given the

development of many specific tools for water accounting (e.g. water footprint) a low-effort/low-cost approach for corporate water accounting along entire supply chains to aid corporate decision-making is missing. As a specification of eco-efficiency they devise a *Regionalized Cumulative Water Intensity* ratio which shows how many m^3 equivalent of water were withdrawn to create an added value of £1 where withdrawing 1 m^3 of water per £ in regions affected by severe water scarcity will lead to a higher ratio than withdrawing the same volume in an area where water is abundant. The benefit of the Regionalized Cumulative Water Intensity method of water accounting they develop and examine for the cotton textile industry is that it includes environmental, economic and social aspects of the supply chain to assist with comparison of water performance of different suppliers and supplier combinations.

Joa et al's (2014) study indicates that in the cotton industry, where the supply chain examined includes agricultural product (cotton fibres) and production (spinning, weaving, knitting, dying leading to the final garment), results show that even though the water footprint of cotton textiles is often dominated by the water used at the raw material stage, the selection of the further suppliers is of importance to value added and affects decisions in the context of a comprehensive assessment of global supply chains. At this stage the analysis is partial and excludes wastewater considerations. A full analysis requires more effort and cost. While the case focuses on the global aspect of cotton garment supply chains from three different cotton growing areas for three different garments and integrates the various aspects of sustainability, the authors note that economic information was the most difficult to gather for Regionalized Cumulative Water Intensity calculations. This is something with which accountants are conventionally best able to assist and for which there is potential future demand, although Schaltegger and Csutora (2012) find that the monetary aspects of carbon accounting are only just emerging.

Accounting for efficiency of the different processes in the paper production supply chain, a highly polluting chain, is examined by Manzardo et al. (2014). Chemical pulp production and supply is a significant freshwater use hotspot in paper production and a crucial aspect for economic success (Manzardo et al., 2014). The aim of the multi-criteria decision analysis model considering cost and environmental performance is to optimize the supply mix of chemical pulps from different countries that minimizes water footprint accounting and costs. The study aims to quantify water footprint accounting for the different chemical pulp supplies required to produce 1 tonne of final paper product using virgin fibre wood from North and South America by an Italian paper mill. The eco-efficiency measure is m3/tonne of finished paper product. The supply chain includes: wood growth, wood harvesting and chemical pulp production.

Accounting detail is not considered here but 'based only on water footprint accounting, the company should prefer chemical pulp produced from eucalyptus in the subtropical biome [i.e. forest] of Brazil' (Manzardo et al., 2014, p. 170) and based only on cost, the paper company considered in the study should buy chemical pulp only from Chile. The two conflicting results were addressed by developing a model which the results of the application of the six-step approach developed can be used to integrate the water footprint accounting and cost parameters for chemical pulp, demonstrating the importance of accounting for the two stages of the supply chain. As with Joa et al. (2014) the optimization model allows for extension to include the integration of other variables that consider environmental, economic, and even social aspects but would also be complex for a decision maker and aimed only at sophisticated (large) companies. Yet the need for a more comprehensive approach in accounting for supply chains is critical for addressing sustainability issues and requires attention in future research (Schaltegger & Csutora, 2012).

Christ (2014) examines the wine industry in Australia, which has about 2500 organisations, and finds in 363 useable responses from interviews with managers there is a movement beyond the mere reporting of water-related matters to external parties. Indeed, results indicate that water management across supply chains in the industry has significant potential to improve economic and environmental performance of the chain. In her study Christ (2014) found the use of water management accounting (WMA) for evaluating the long-term implications of water management in wine supply chains to be associated with a combination of contingent and institutional factors. The results suggest the use of EMA for supply chain water management is driven not only by strategic concerns designed to enhance organisational performance, but also by external forces that may be important to maintaining the organisation's licence to operate. In addition it was found the forces associated with the use of physical and monetary information can differ implying the two elements of EMA may need to be considered separately in future research. Christ (2014) concludes by using her findings to offer a potential way forward for the Australian wine industry whereby the use of WMA information for long-term supply chain water management can be supported and improved.

5.7. Sustainability balanced scorecard

A customised scorecard design for sustainable supply chains is provided by Carbone, Moatti, and Vinzi (2012). It is founded on the idea that concentration on overall sustainability supply chain performance will correlate highly with the social and environmental performance of individual members of a supply chain. Balanced scorecard sustainability performance measures go beyond conventional accounting as they focus on non-monetary performance in a similar way to earlier developed environmental management accounting (Figge, Hahn, Schaltegger, & Wagner, 2002). While it emphasises value to the business through performance in relation to financials, customers, internal processes and learning and growth as well as social and environmental aspects of the business, the sustainable supply chain balanced scorecard in addition needs to consider the different levels of supply chain issues.

These issues include "supply policy, supply strategy, supply management and supply operations" (Reefke & Trocchi, 2013, p. 813). Hence, added to the monetary and non-monetary accounting information required for a sustainability balanced

scorecard (Figge et al., 2002; Schaltegger & Wagner, 2006; Hansen & Schaltegger, 2014), is the additional accounting for the supply chain levels such as whether suppliers comply with environmental regulations, or social standards, plans to ensure expected supplies will be available (through physical budgeting), and ex post assessment of supply performance. Accounting is important for sustainable supply chain management to succeed as (Reefke & Trocchi, 2013, p. 817) acknowledge "Ultimately, a BSC for SSCM [Sustainable Supply Chain Management] has to be based on information availability and measurability which relates directly to practical issues regarding information sharing." They cite the case of the Puma Corporation where only 6% of environmental impacts are directly caused by the focal company.

Of importance is that implementation should start with simple measures to ensure compliance with regulations and standards (e.g. see detailed measures in Reefke and Trocchi, 2013, Table 5). Complex mathematical models will not promote take-up. Supply chain performance measurements linked to objectives and strategies are hampered by local optimisations, focus on cost rather than non-cost indicators and lack of an integrated systems perspective.

There is a clear need for alignment between sustainable supply chain management and measurement practices (Grosvold, Hoejmose, & Roehrich, 2014). Taticchi, Tonelli, and Pasqualino (2013) specifically consider these needs at the conceptual level. However, they do not examine accounting although its importance is implicit when they suggest the need to look for maximum profitability, maximum social well-being and minimum environmental impacts in a triple bottom line setting. They find supply chain sustainability balanced scorecard wanting, but being led by practitioners rather than academics.

6. Reporting on supply chain activities

Disclosure of sustainability supply chain initiatives is based on accounting data gathered and reported by management. Okongwu, Morimoto, and Lauras (2013) obtain empirical evidence about the maturity level at a point in time of such disclosures in the sustainability reports in ten industries, relative to a closed-loop supply chain ideal. The sample includes business to business industries – aerospace, chemical, construction and energy, and business to consumer industries – food, electronics, pharmaceutical, retail and telecommunications. The authors find disclosures on environmental and social matters have greater maturity in the business to consumer industries, the rationale being that final consumers exert greater pressure for disclosure than businesses transferring intermediate products. Also business to business industry disclosures focus more on upstream than business to consumer businesses. The absence of accounting tools for measuring and reporting sustainability performance is noted as a possible reason why principal component analysis cannot detect linkages between the main sustainability component disclosures (social, environmental and economic).

Deegan and Islam (2014) extend examination of extra-organisational aspects of multinational supply chain reporting. The context is the garment and textile industry in Bangladesh which receives much global attention, especially since the large loss of life in the Tazreen factory fire. Their concern is the impact of non-government organisations on media in securing change in supply chain activities, associated corporate reporting and the importance of legitimacy of operations in the supply chain setting.

Another aspect of reporting related to accounting for sustainability in production and supply chains is the growing interest in Global Reporting and Integrated Reporting initiatives. The Global Reporting Initiative, being the most notable in terms of sustainability reporting, established a working group in recognition that "sustainability reports overall provide an incomplete picture of supply chain performance despite the importance of the issue" (GRI, 2014). Specific supply chain disclosures are encouraged such as G 4-12 'Describe the organization's supply chain' and G 4-13 'Report any significant changes … regarding the organization's … supply chain, including: changes in the location of suppliers, the structure of the supply chain, or in the relationships with suppliers, including selection and termination.' These and more detailed Indicators have been incorporated into the latest Global Reporting Initiative G4 guidelines. Varsei et al. (2014) provide a framework for managing and assessing supply chain sustainability based on Global Reporting Initiative measures. The Indicators have been applied in a number of industries e.g. fast fashion sustainability reporting by 9 companies where globalisation and branding are important considerations (Turker & Altuntas, 2014) and food industry (Maloni & Brown, 2006). One ongoing issue is that the Global Reporting Initiative gives discretion as to how company managers address the definition of entity boundaries, the development/requirement of integrated indicators and assurance of content leaving sustainability as a notion under the control of management (Moneva, Archel, & Correa, 2006). To date such issues are little examined in the supply chain context using Global Reporting Initiative disclosures (Foran et al., 2005).

Integrated reporting is the latest in a set of reporting approaches that move beyond the narrow confines of financial reporting and includes financial, environmental and social data in the one report about a company's performance. As a new reporting approach little research has been conducted on supply chain, sustainable supply chain or accounting for these. Okongwu et al. (2013) suggest that introduction of comprehensive integrated reporting is a framework that will promote systematic analysis of sustainable supply chain disclosure and reduce the gap between theory and practice (Burritt and Tingey-Holyoak, 2012). At this stage of development little evidence is available about the sustainable supply chain aspects of integrated reporting, with conferences, fora and growing interest from the profession in the supply chain aspects the current norm.

7. Conclusion and possible future directions

This search of relevant literature aims to detect possible avenues for accounting in the context of sustainable production and supply chains. Readers looking for a simple recipe for accounting for production and supply chains will be disappointed as

the reviewed research is still fairly immature and in an ongoing state of development. Definitional issues are legion: corporate sustainability, accounting, supply chain management remain contested terms.

Nevertheless, several clear avenues for future research emerge from the review of the existing literature on accounting for production and supply chains.

First, is the recognition that there is a *new entity for accounting* – the supply chain, unbounded by the legal fiction of corporate form, but nevertheless with parties beholden to the necessity to maintain legitimacy and to comply with the rules of laws throughout the supply chain, whether through e.g. common, code or Islamic law. The new entity involves movement from narrow accounting for firms in manufacturing or service industries towards broader measurement and disclosure required for supply chains. Accounting for the supply chain is different from accounting for the focal company and merits further comparative research.

Second, research is needed into *who* undertakes the management and accounting for supply chains in order to identify and secure the potential benefits. The parties to a simple supply chain include a supplier, focal company and customer, either business to business with intermediate products, or business to final consumer. A question of best governance arises which has high relevance for the matter of whom the organizing actor for accounting for sustainability in a supply chain could be. To secure the benefits of supply chains research is needed into who actually does the accounting for supply chains and who has the capability to undertake such accounting and can do it. Present literature indicates there is a tendency for research to focus on sub-issues in sustainability such as specific environmental issues using complex mathematical models. In addition, as with sustainability management in general (Schaltegger et al., 2013) accounting for sustainability in supply chains needs transdisciplinary teams as different skills are called for with different environmental and social issues (e.g. engineers and hydrologists are needed for water-related environmental management accounting for supply chains concerned with droughts or floods).

Third, the issue of *why any corporate function* should undertake the management and accounting of supply chains remains unaddressed. The possible targets include sub-units within the focal company (e.g. procurement accountant, research and development accountant, divisional accountant), the focal company itself (e.g. chief finance officer), the organisations within the supply chain (the divisional accountants or chief finance officers of supplier or purchaser businesses or governments), the supply chain itself (a special supply chain accountant) and organisations outside the supply chain (e.g. non-government organisations, professional associations). Paths towards identification of the reasons why an institution allocates the task of supply chain accounting for sustainability in a particular way will continue to be revealed as different tools, environmental themes, social uncertainties, economic circumstances, cultural and industry considerations emerge over time. Research is needed into why certain groups manage and account for sustainability issues in part of or the whole supply chain.

Fourth, the ongoing development of accounting for sustainability of production and supply chains will need to address the *tension between being comprehensive* and considering all sustainability issues *and the need to focus on relevant key aspects*, such as greenhouse gases for an airline or toxicity for a food producer. The tension needs to be resolved through development of new accounting and performance measurement and management approaches which support a process of criteria based prioritization and do not lead to the neglect of other relevant sustainability aspects.

Fifth, the question of *what sustainability accounting information* is relevant to the supply chain decisions made by different managers remains for investigation. A start has been made in the environmental management accounting literature but extension is needed and should recognise the importance of obtaining and combining physical data and monetary data as the basis for indicators of different performances, the use of this data over time and the range of decision settings. Provision of relevant environmental management accounting information to supply chain managers would be particularly useful.

In summary, this new research agenda in accounting for sustainability in production and supply chains could be assisted by: over time a better understanding and convergence of opinions about terminology; development of better quantifiable measures of environmental and social impacts, their trade-offs and integration with economic performance; improved education of accountants by their professional bodies and universities in relation to skills in sustainable supply chains and supply chain networking; progress with the largely absent theoretical foundations for accounting for sustainable supply chain management; development of simpler rules of thumb for practitioners managing supply chain relationships to improve sustainability; advances in accounting for sustainable logistics; greater focus on accounting for sustainability as an input to the work of transdisciplinary teams with a focus on supply chains and networks and who will control such accounting; development of ideal, technically achievable and pragmatic benchmarks for comparing excellent, good and poor performance of supply chains and supply networks in emerging, developing and developed countries.

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References

Acquaye, A., Genovese, A., Barrett, J., & Koh, S. C. (2014). Benchmarking carbon emissions performance in supply chains. *Supply Chain Management: An International Journal, 19*(3), 306–321.

Albright, T., & Davis, S. (1999). The elements of supply chain management. *International Journal of Strategic Cost Management*, 49–65.
Apgar, J. M., Argumedo, A., & Allen, W. (2009). Building transdisciplinarity for managing complexity: lessons from indigenous practice. *International Journal of Interdisciplinary Social Sciences, 4*(5), 255–270.
Arzoumanidis, I., Fullana-i-Palmer, P., Raggi, A., Gazulla, C., Raugei, M., Benveniste, G., et al. (2014). Unresolved issues in the accounting of biogenic carbon exchanges in the wine sector. *Journal of Cleaner Production, 82*, 16–22.
Ascui, F., & Lovell, H. (2011). As frames collide: making sense of carbon accounting. *Accounting, Auditing and Accountability Journal, 24*(8), 978–999.
Ascui, F., & Lovell, H. (2012). Carbon accounting and the construction of competence. *Journal of Cleaner Production, 36*, 48–59.
Askarany, D., Yazdifar, H., & Askary, S. (2010). Supply chain management, activity-based costing and organisational factors. *International Journal of Production Economics, 127*(2), 238–248.
Bai, C., & Sarkis, J. (2014a). Determining and applying sustainable supplier key performance indicators. *Supply Chain Management: An International Journal, 19*(3), 275–291.
Bai, C., & Sarkis, J. (2014b). Green supply chain technology: a comprehensive evaluation and justification multiattribute decision modeling approach. In *Supply chain management under fuzziness* (pp. 655–679). Berlin Heidelberg: Springer.
Baker, M., & Schaltegger, S. (2015). Taking pragmatism seriously in social accounting research. *Accounting, Auditing and Accountability Journal* (in press).
Beckmann, M., Hielscher, S., & Pies, I. (2014). Commitment strategies for sustainability: how business firms can transform trade-offs into win–win outcomes. *Business Strategy and the Environment, 23*(1), 18–37.
Benjaafar, S., Li, Y., & Daskin, M. (2013). Carbon footprint and the management of supply chains: insights from simple models. *Automation Science and Engineering, IEEE Transactions on, 10*(1), 99–116.
Bennett, M., Schaltegger, S., & Zvezdov, D. (2013). *Exploring corporate practices in management accounting for sustainability*. London: Institute for Chartered Accountants of England and Wales (ICAEW).
Beske, P., & Seuring, S. (2014). Putting sustainability into supply chain management. *Supply Chain Management: An International Journal, 19*(3), 322–331.
Bhattacharya, A., Mohapatra, P., Kumar, V., Dey, P. K., Brady, M., Tiwari, M. K., et al. (2013). Green supply chain performance measurement using fuzzy ANP-based balanced scorecard: a collaborative decision-making approach. *Production Planning & Control*, 1–17 (ahead-of-print).
Boyd, D. E., Spekman, R. E., Kamauff, J. W., & Werhane, P. (2007). Corporate social responsibility in global supply chains: a procedural justice perspective. *Long Range Planning, 40*(3), 341–356.
Braziotis, C., Bourlakis, M., Rogers, H., & Tannock, J. (2013). Supply chains and supply networks: distinctions and overlaps. *Supply Chain Management: An International Journal, 18*(6), 644–652.
Burritt, R. L. (2004). Environmental management accounting: roadblocks on the way to the green and pleasant land. *Business Strategy and the Environment, 13*(1), 13–32.
Burritt, R. L., Hahn, T., & Schaltegger, S. (2002). Towards a comprehensive framework for environmental management accounting—Links between business actors and environmental management accounting tools. *Australian Accounting Review, 12*(27), 39–50.
Burritt, R. L., & Schaltegger, S. (2010). Sustainability accounting and reporting: fad or trend? *Accounting, Auditing and Accountability Journal, 23*(7), 829–846.
Burritt, R. L., & Tingey-Holyoak, J. (2012). Forging cleaner production: the importance of academic-practitioner links for successful sustainability embedded carbon accounting. *Journal of Cleaner Production, 36*, 39–47.
Burritt, R. L., Schaltegger, S., Bennett, M., Pohjola, T., & Csutora, M. (2011). Sustainable supply chain management and environmental management accounting. In R. L. Burritt, S. Schaltegger, M. Bennett, T. Pohjola, & M. Csutora (Eds.), *Environmental management accounting and supply chain management* (pp. 3–20). Amsterdam: Springer.
Burritt, R. L., Schaltegger, S., & Zvezdov, D. (2011). Carbon management accounting: explaining practice in leading German companies. *Australian Accounting Review, 21*(1), 80–98.
Callens, I., & Tyteca, D. (1999). Towards indicators of sustainable development for firms: a productive efficiency perspective. *Ecological Economics, 28*(1), 41–53.
Carbone, V., Moatti, V., & Vinzi, V. E. (2012). Mapping corporate responsibility and sustainable supply chains: an exploratory perspective. *Business Strategy and the Environment, 21*(7), 475–494.
Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution and Logistics Management, 38*(5), 360–387.
Chambers, R. J. (1966). *Accounting, evaluation and economic behavior*. Houston, USA: Scholars Book Co.
Chan, H. K., Wang, X., & Ruffoni, A. (2014). An integrated approach for green design: life-cycle, fuzzy AHP and environmental management accounting. *British Accounting Review, 46*(4), 344–360.
Christ, K. (2014). Water management accounting and the wine supply chain: empirical evidence from Australia. *British Accounting Review, 46*(4), 379–396.
Christ, K. L., & Burritt, R. L. (2014). Material flow cost accounting: a review and agenda for future research. *Journal of Cleaner Production* (in press).
Clarke-Sather, A. R., Hutchins, M. J., Zhang, Q., Gershenson, J. K., & Sutherland, J. W. (2011). Development of social, environmental, and economic indicators for a small/medium enterprise. *International Journal of Accounting and Information Management, 19*(3), 247–266.
Colicchia, C., Melacini, M., & Perotti, S. (2011). Benchmarking supply chain sustainability: insights from a field study. *Benchmarking: An International Journal, 18*(5), 705–732.
De Castro, J. O., Khavul, S., & Bruton, G. D. (2014). Shades of grey: how do informal firms navigate between macro and meso institutional environments? *Strategic Entrepreneurship Journal, 8*(1), 75–94.
Deegan, C. (2007). *Financial accounting theory* (2nd ed.). North Ryde, Australia: McGraw-Hill Australia Pty Ltd.
Deegan, C., & Islam, A. (2014). An exploration of NGO and media efforts to influence workplace practices and associated accountability within global supply chains. *British Accounting Review, 46*(4), 397–415.
Dekker, H. C., & van Goor, A. R. (2000). Supply chain management and management accounting: a case study of activity based costing. *International Journal of Logistics: Research and Applications, 3*(1), 41–52.
Dillard, J., & Roslender, R. (2011). Taking pluralism seriously: embedded moralities in management accounting and control systems. *Critical Perspectives on Accounting, 22*(2), 135–147.
Ditz, D. W., Ranganathan, J., & Banks, R. D. (1995). *Green Ledgers: Case studies in corporate environmental accounting*. Washington, D.C.: World Resources Institute.
Elkington, J. (1998). *Cannibals with folks. The triple bottom line of 21 century business*. Gabriola Island, BC Canada: New Society Publishers.
Ellram, L. M., & Cooper, M. C. (2014). Supply chain management: it's all about the journey, not the destination. *Journal of Supply Chain Management, 50*(1), 8–20.
Federal Environment Ministry and Federal Environment Agency. (2003). *Guide to corporate environmental cost management*. Berlin, Germany.
Figge, F., Hahn, T., Schaltegger, S., & Wagner, M. (2002). The sustainability balanced scorecard. Linking sustainability management to business strategy. *Business Strategy and the Environment, 11*(5), 269–284.
Foran, B., Lenzen, M., Dey, C., & Bilek, M. (2005). Integrating sustainable chain management with triple bottom line accounting. *Ecological Economics, 52*(2), 143–157.
Foxon, T. J. (2011). A coevolutionary framework for analysing a transition to a sustainable low carbon economy. *Ecological Economics, 70*(12), 2258–2267.
Gale, R. (2006). Environmental costs at a Canadian paper mill: a case study of environmental management accounting. *Journal of Cleaner Production, 14*, 1237–1251.
Gibson, B. J., Mentzer, J. T., & Cook, R. L. (2005). Supply chain management: the pursuit of a consensus definition. *Journal of Business Logistics, 26*(2), 17–25.
Global Reporting Initiative (GRI). (2014). *Supply chain disclosure working group* Accessed 18.08.14 https://www.globalreporting.org/reporting/g4/g4-developments/g4-working-groups/Pages/Supply-Chain.aspx.

Gold, S., Seuring, S., & Beske, P. (2010). Sustainable supply chain management and inter-organizational resources: a literature review. *Corporate Social Responsibility and Environmental Management, 17*(4), 230–245.
Gopalakrishnan, K., Yusuf, Y. Y., Musa, A., Abubakar, T., & Ambursa, H. M. (2012). Sustainable supply chain management: a case study of British Aerospace (BAe) Systems. *International Journal of Production Economics, 140*(1), 193–203.
Gosselin, M. (1997). The effect of strategy and organizational structure on the adoption and implementation of activity-based costing. *Accounting, Organizations and Society, 22*(2), 105–122.
Govindan, K., Khodaverdi, R., & Jafarian, A. (2013). A fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach. *Journal of Cleaner Production, 47*(1), 345–354.
Gray, R. (2010). Is accounting for sustainability actually accounting for sustainability… and how would we know? An exploration of narratives of organisations and the planet. *Accounting, Organizations and Society, 35*(1), 47–62.
Grosvold, J., Hoejmose, S., & Roehrich, J. (2014). Squaring the circle: management, measurement and performance of sustainability in supply chains. *Supply Chain Management: An International Journal, 19*(3), 292–305.
Gualandris, J., Golini, R., & Kalchschmidt, M. (2014). Do supply management and global sourcing matter for firm sustainability performance? An international study. *Supply Chain Management: An International Journal, 19*(3), 258–274.
Gulati, R., Lavie, D., & Singh, H. (2009). The nature of partnering experience and the gains from alliances. *Strategic Management Journal, 30*(11), 1213–1233.
Hahn, T., Figge, F., Pinkse, J., & Preuss, L. (2010). Trade-offs in corporate sustainability: you can't have your cake and eat it. *Business Strategy and the Environment, 19*, 217–229.
Hansen, E., & Schaltegger, S. (2014). The Sustainability Balanced Scorecard: A Systematic Review of Architectures. *Journal of Business Ethics*. online.
Harms, D., Hansen, E., & Schaltegger, S. (2013). Strategies in aligning supply chains for sustainability. An empirical investigation of large German companies. *Corporate Social Responsibility and Environmental Management, 20*(4), 205–218.
Harms, D., & Klewitz, J. (2013). Innovation in sustainable supply chains. Interaction for resources from an SME perspective. In R. Bogaschewsky, M. Esig, R. Lasch, & W. Stölzle (Eds.), *Supply management research* (pp. 105–130). Wiesbaden: Gabler: Aktuelle Forschungsergebnisse.
Herzig, C., Viere, T., Schaltegger, S., & Burritt, R. (2012). *Environmental management accounting: Case studies of South-East Asian companies*. New York, N.Y: Routledge.
Henri, J. F., & Journeault, M. (2010). Eco-control: the influence of management control systems on environmental and economic performance. *Accounting, Organizations and Society, 35*(1), 63–80.
Hillman, A. J., & Keim, G. D. (2001). Shareholder value, stakeholder management, and social issues: what's the bottom line? *Strategic Management Journal, 22*(2), 125–139.
Hoffmann, V. H., & Busch, T. (2008). Corporate carbon performance indicators. *Journal of Industrial Ecology, 12*(4), 505–520.
International Organization for Standardization (ISO). (2011). *ISO 14051: Environmental management: Material flow cost accounting: General framework*. Geneva, Switzerland: International Organization for Standardization, 15 September.
Jalaludin, D., Sulaiman, M., & Ahmed, N. N. N. (2011). Understanding environmental management accounting (EMA) adoption: a new institutional perspective. *Social Responsibility Journal, 7*(4), 540–557.
Jasch, C. (2003). The use of Environmental Management Accounting (EMA) for identifying environmental costs. *Journal of Cleaner Production, 11*(6), 667–676.
Jasch, C. (2009). *Environmental and material flow cost design. Principles and procedures*. Dordrecht, Netherlands: Springer Netherlands.
Jasch, C. (2011). Environmental management accounting: comparing and linking requirements at micro and macro levels – a practitioner's view. In R. L. Burritt, S. Schaltegger, M. Bennett, T. Pohjola, & M. Csutora (Eds.), *Environmental management accounting and supply chain management* (pp. 255–277). Netherlands: Springer.
Jindrichovska, I., & Purcărea, I. (2011). CSR and environmental reporting in the Czech Republic and Romania: country comparison of rules and practices. *Journal of Accounting and Management Information Systems, 10*, 202–227.
Joa, B., Hottenroth, H., Jungmichel, N., & Schmidt, M. (2014). Introduction of a feasible performance indicator for corporate water accounting – a case study on the cotton textile chain. *Journal of Cleaner Production, 82*(1), 143–153.
Klassen, R. D., & Vachon, S. (2003). Collaboration and evaluation in the supply chain: the impact on plant level environmental investment. *Production and Operations Management, 12*(3), 336–352.
Klassen, R. D., & Vereecke, A. (2012). Social issues in supply chains: capabilities link responsibility, risk (opportunity), and performance. *International Journal of Production Economics, 140*(1), 103–115.
Kokubu, K., & Tachikawa, H. (2013). Material flow cost accounting: significance and practical approach. In J. Kauffman, & K.-M. Lee (Eds.), *Handbook of sustainable engineering* (pp. 351–369). Netherlands: Springer.
KPMG. (2014). Global manufacturing outlook. In *Performance in the crosshairs*. KPMG International Cooperative. Cited online at http://kpmg.com/gmo. on 25 July 2014.
Lambert, D. M., & Pohlen, T. L. (2001). Supply chain metrics. *The International Journal of Logistics Management, 12*(1), 1–19.
Lamberton, G. (2005). Sustainability accounting. A brief history and conceptual framework. *Accounting Forum, 29*(1), 7–26.
Lee, K. H. (2012). Carbon accounting for supply chain management in the automobile industry. *Journal of Cleaner Production, 36*, 83–93.
Lee, K.-H., & Wu, Y. (2014). Integrating sustainability performance measurement into logistics and supply networks: a multi-methodological approach. *British Accounting Review, 46*(4), 361–378.
Longinidis, P., & Georgiadis, M. C. (2014). Integration of sale and leaseback in the optimal design of supply chain networks. *Omega, 47*(1), 73–89.
Maloni, M. J., & Brown, M. E. (2006). Corporate social responsibility in the supply chain: an application in the food industry. *Journal of Business Ethics, 68*(1), 35–52.
Manzardo, A., Ren, J., Piantella, A., Mazzi, A., Fedele, A., & Scipioni, A. (2014). Integration of water footprint accounting and costs for optimal chemical pulp supply mix in paper industry. *Journal of Cleaner Production, 72*(1), 167–173.
Mentzner, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., et al. (2001). Defining supply chain management. *Journal of Business Logistics, 22*(2), 1–25.
Milne, M. J. (1996). On sustainability; the environment and management accounting. *Management Accounting Research, 7*(1), 135–161.
Min, H., & Kim, I. (2012). Green supply chain research: past, present, and future. *Logistics Research, 4*(1–2), 39–47.
Ministry of Economy, Trade and Industry (METI). (2007). *Guide for material flow cost accounting. Version 1*. Tokyo, Japan: Ministry of Economy, Trade and Industry. March.
Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a theory of stakeholder identification and salience: defining the principle of who and what really counts. *Academy of Management Review, 22*(4), 853–886.
Moneva, J. M., Archel, P., & Correa, C. (2006). GRI and the camouflaging of corporate unsustainability. *Accounting Forum, 30*(2), 121–137.
Money, A. (2014). Corporate water risk: a critique of prevailing best practice. *Journal of Management and Sustainability, 4*(1), 42.
Okongwu, U., Morimoto, R., & Lauras, M. (2013). The maturity of supply chain sustainability disclosure from a continuous improvement perspective. *International Journal of Productivity and Performance Management, 62*(8), 827–855.
Olsthoorn, X., Tyteca, D., Wehrmeyer, W., & Wagner, M. (2001). Environmental indicators for business: a review of the literature and standardisation methods. *Journal of Cleaner Production, 9*, 453–463.
Ortas, E., Moneva, J., & Álvarez, I. (2014). Sustainable supply chain and company performance: a global examination. *Supply Chain Management: An International Journal, 19*(3), 332–350.
Padgett, J. P., Steinemann, A. C., Clarke, J. H., & Vandenbergh, M. P. (2008). A comparison of carbon calculators. *Environmental Impact Assessment Review, 28*(2), 106–115.

Penela, A. C., García-Negro, M. D. C., & Quesada, J. L. D. (2009). A methodological proposal for corporate carbon footprint and its application to a wine-producing company in Galicia, Spain. *Sustainability, 1*(2), 302–318.
Ramdas, K., & Spekman, R. E. (2000). Chain or shackles: understanding what drives supply-chain performance. *Interfaces, 30*(4), 3–21.
Ramos, M. M. (2004). Interaction between management accounting and supply chain management. *Supply Chain Management: An International Journal, 9*(2), 134–138.
Reefke, H., & Trocchi, M. (2013). Balanced scorecard for sustainable supply chains: design and development guidelines. *International Journal of Productivity and Performance Management, 62*(8), 805–826.
Rugani, B., Vázquez-Rowe, I., Benedetto, G., & Benetto, E. (2013). A comprehensive review of carbon footprint analysis as an extended environmental indicator in the wine sector. *Journal of Cleaner Production, 54*, 61–77.
Sarac, A., Absi, N., & Dauzère-Pérès, S. (2010). A literature review on the impact of RFID technologies on supply chain management. *International Journal of Production Economics, 128*(1), 77–95.
Schalteger, S., & Burritt, R. L. (2014). Measuring and managing sustainability performance of supply chains. Review and sustainability supply chain management framework. *Supply Chain Management: An International Journal, 19*(3), 232–241.
Schaltegger, S. (1998). Accounting for eco-efficiency. In B. Nath, L. Hens, P. Compton, & D. Devuyst (Eds.), *Instruments for environmental management: Vol. I. Environmental management in practice* (pp. 272–287). London: Routledge.
Schaltegger, S., Beckmann, M., & Hansen, E. (2013). Transdisciplinarity in corporate sustainability. Mapping the field. *Business Strategy and the Environment, 22*, 219–229.
Schaltegger, S., Bennett, M., & Burritt, R. (2006). Sustainability accounting and reporting. Development, linkages and reflection. In S. Schaltegger, M. Bennett, & R. Burritt (Eds.), *Sustainability accounting and reporting* (pp. 1–34). Dordrecht: Springer.
Schaltegger, S., & Burritt, R. L. (2000). *Contemporary environmental accounting: Issues, concepts and practice*. Sheffield: Greenleaf Publishing.
Schaltegger, S., & Burritt, R. L. (2005). Corporate sustainability. In H. Folmer, & T. Tietenberg (Eds.), *The international yearbook of environmental and resource economics* (pp. 185–232). Cheltenham: Edward Elgar.
Schaltegger, S., Burritt, R., & Petersen, H. (2003). *An introduction to corporate environmental management: Striving for sustainability*. Sheffield, England: Greenleaf Publishing.
Schaltegger, S., & Csutora, M. (2012). Carbon accounting for sustainability and management. Status quo and challenges. *Journal of Cleaner Production, 36*(1), 1–16.
Schaltegger, S., & Wagner, M. (2006). Integrative management of sustainability performance, measurement and reporting. *International Journal of Accounting, Auditing and Performance Evaluation (IJAAPE), 3*(1), 1–19.
Schaltegger, S., Gibassier, D., & Zvezdov, D. (2013). Is environmental management accounting a discipline? A bibliometric literature review. *Meditari Accountancy Research, 21*(1), 4–31.
Schaltegger, S., & Sturm, A. (1992). Eco-controlling: an integrated economic–ecological management tool. In D. Köchlin, & K. Müller (Eds.), *Green business opportunities. The profit potential* (pp. 228–240). London: Pitman Publishing/Financial Times.
Schaltegger, S., & Sturm, A. (1996). Managerial eco-control in manufacturing and process industries. *Greener Management International, 13*(1), 78–91.
Schaltegger, S., & Synnestvedt, T. (2002). The link between 'green' and economic success: environmental management as the crucial trigger between environmental and economic performance. *Journal of Environmental Management, 65*(4), 339–346.
Schaltegger, S., & Figge, F. (2000). Environmental shareholder value. Economic success with corporate environmental management. *Eco-Management and Auditing, 7*(1), 29–42.
Schaltegger, S., & Zvezdov, D. (2014). Expanding material flow cost accounting. Framework, review and potentials. *Journal of Cleaner Production* (online).
Schniederjans, M. J., & Garvin, T. (1997). Using the analytic hierarchy process and multi-objective programming for the selection of cost drivers in activity-based costing. *European Journal of Operational Research, 100*(1), 72–80.
Schrack, D., & Prammer, H. K. (2013). Integration of external costs and environmental impacts in material flow cost accounting – a life cycle oriented approach. In E. Guenther, & A. Bergmann (Eds.), *Proceedings from the EMAN-EU 2013 Conference on Material Flow Cost Accounting* (pp. 150–154). Singapore: Springer.
Schulze, M., Seuring, S., & Ewering, C. (2012). Applying activity-based costing in a supply chain environment. *International Journal of Production Economics, 135*(2), 716–725.
Seal, W., Cullen, J., Dunlop, A., Berry, T., & Ahmed, M. (1999). Enacting a European supply chain: a case study on the role of management accounting. *Management Accounting Research, 10*(3), 303–322.
Seuring, S., & Goldbach, M. (Eds.). (2002). *Cost management in supply chains*. Heidelberg: Physica/Springer.
Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production, 16*, 1699–1710.
Shank, J. K., & Govindarajan, V. (1992). Strategic cost analysis of technological investments. *Sloan Management Review, 34*(1), 39–51.
Shi, V. G., Koh, S. L., Baldwin, J., & Cucchiella, F. (2012). Natural resource based green supply chain management. *Supply Chain Management: An International Journal, 17*(1), 54–67.
Signori, S., & Bodino, G. A. (2013). Water management and accounting: remarks and new insights from an accountability perspective. *Studies in Managerial and Financial Accounting, 26*, 115–161.
Srivastava, S. K. (2007). Green supply-chain management: a state-of-the-art literature review. *International Journal of Management Reviews, 9*(1), 53–80.
Stonebraker, P. W., Goldhar, J., & Nassos, G. (2009). Weak links in the supply chain: measuring fragility and sustainability. *Journal of Manufacturing Technology Management, 20*(2), 161–177.
Taticchi, P., Tonelli, F., & Pasqualino, R. (2013). Performance measurement of sustainable supply chains: a literature review and a research agenda. *International Journal of Productivity and Performance Management, 62*(8), 782–804.
Thrane, S., & Hald, K. S. (2006). The emergence of boundaries and accounting in supply fields: the dynamics of integration and fragmentation. *Management Accounting Research, 17*(3), 288–314.
Tsai, W. H., & Hung, S. J. (2009). A fuzzy goal programming approach for green supply chain optimization under activity-based costing and performance evaluation with a value-chain structure. *International Journal of Production Research, 47*(18), 4991–5017.
Turker, D., & Altuntas, C. (2014). Sustainable supply chain management in the fast fashion industry: an analysis of corporate reports. *European Management Journal, 32*(5), 837–849.
United States Environmental Protection Agency (US EPA). (1995). *An introduction to environmental accounting as a business management tool: Key concepts and terms*. Washington D. C., USA: Office of Pollution Prevention and Toxics.
van der Vaart, T., & Van Donk, D. P. (2004). Buyer focus: evaluation of a new concept for supply chain integration. *International Journal of Production Economics, 92*(1), 21–30.
Ván, H., & Gärtner, S. (2011). The benefit side of environmental activities and the connection with company value. In R. L. Burritt, et al. (Eds.), *Environmental management accounting and supply chain management* (pp. 281–300). Springer.
Varsei, M., Soosay, C., Fahimnia, B., & Sarkis, J. (2014). Framing sustainability performance of supply chains with multidimensional indicators. *Supply Chain Management: An International Journal, 19*(3), 242–257.
Vasileiou, K., & Morris, J. (2006). The sustainability of the supply chain for fresh potatoes in Britain. *Supply Chain Management: An International Journal, 11*(4), 317–327.
Wang, Z., & Sarkis, J. (2013). Investigating the relationship of sustainable supply chain management with corporate financial performance. *International Journal of Productivity and Performance Management, 62*(8), 871–888.

Weigand, H., & Elsas, P. (2013). Construction and use of environmental management accounting systems with the REA business ontology. *Journal of Emerging Technologies in Accounting, 9*, 25–46.
Wiengarten, F., Humphreys, P., McKittrick, A., & Fynes, B. (2013). Investigating the impact of e-business applications on supply chain collaboration in the German automotive industry. *International Journal of Operations & Production Management, 33*(1), 25–48.
von Weizsäcker, E. U., Hargroves, K., Smith, M., Desha, C., & Stasinopoulos, P. (2009). *Factor five. Transforming the global economy through 80% improvements in resource productivitiy*. London: Edward Elgar.
Wood, G., & Budhwar, P. (2014). Advancing theory and research and the British Journal of Management. *British Journal of Management, 25*(1), 1–3.
World Commission on Environment and Development (WCED). (1987). *Our common future* (Vol. 383). Oxford, UK: Oxford University Press.
World Economic Forum. (2014). *Global risks. 2014*. Insight Report. Geneva: World Economic Forum.
Wynarczyk, P. (2013). Open innovation in SMEs: a dynamic approach to modern entrepreneurship in the twenty-first century. *Journal of Small Business and Enterprise Development, 20*(2), 258–278.
Zhang, Q., Shah, N., Wassick, J., Helling, R., & van Egerschot, P. (2014). Sustainable supply chain optimisation: an industrial case study. *Computers & Industrial Engineering, 74*(1), 68–83.