Sustainable supply chain Management metrics: A Literature Review

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Abstract

Sustainability is the preservation of natural resources for future use. The topic is gaining wide acceptance and recognition because of the adverse effects of human activities on nature. Development doesn't need to be at the cost of environment and this thought has coaxed organizations to advance their sustainability initiatives and to include informed choices in their decisions.

Metrics and indicators are vital because without measurement nothing can be managed or improved. And to put the concept of sustainability in effect, supply chain plays a crucial role as it envisages the flow of material and information. This review paper aims to:

- Scan the literature and current practices used globally by organizations in order to summarize the utilization of the metrics and indicators.
- Highlight other approaches that are suggested by researchers.
- Outline the gaps in the literature and approaches that need further investigation

Keywords: Sustainability, Sustainable metrics/Indicators

1. Introduction

Human activities and requirements are depleting the environmental resources. The impact of such activities is not only exhausting the natural resources but is also causing the environment to act as a sink to the generated waste. Globalization, population growth, rapid urbanization and a growing middle class are all driving competition for increasingly scarce resources—energy, water and raw materials (Sustainability on a Smarter Planet: Going Green and Beyond 2009).Needless to say that sustainability of environment and preservation of natural resources are critically important for the survival of human beings. According to United nation sustainable development Program's Human Development Report 2011. Sustainability is inextricably linked to basic questions of equity — that is, fairness, social justice and greater access to a better quality of life. The report calls for urgent action to slow climate change, prevent further degradation and reduce inequalities, as environmental deterioration threatens to reverse recent progress in human development (United nations 2011)

Thus, sustainability as a concept refers to sustaining, preserving and maintaining the resources for future use. Hence, sustainability is a goal and sustainable development can be the means to achieve that goal (Goodland &daly 1996). Its underlying premise, as contended by Schwarz, Beloff and Beaver (2002), is that economic well-being is inextricably linked to the health of the environment and the success of the world's communities and citizens. Sustainable development as envisaged by Brundtland Commission Report (WCED, 1987, p. 8) is a development, which meets the needs of the present without compromising the ability of the future generations to meet their own needs.

For sustainability, supply chain plays a significant role. As contended by Gupta &Palsule- Desai (2011), amongst the many approaches to mitigation and adaptation, the processes for designing, sourcing, producing and distributing products in global markets play the central role. Supply chain activities account for a bulk of the resources consumed. It contemplates the product from the initial processing of raw materials to the delivery to the end user. Therefore, a focus on supply chains is a step towards the wider adoption and development of sustainability (Ashby et al., 2012).

According to Ernst and Young 2013 six growing trends in corporate sustainability report they found that there is a rise of Inquiries from investors and shareholders on sustainability initiatives in the organizations. The Ernst and Young 2013 report further adds that companies may not talk about climate change per se, but many are being buffeted by its effects. Similar issues including deforestation and shrinking bio-diversity are affecting the availability of agricultural products. As a result, companies are increasingly connecting the dots between risk management and corporate sustainability. That, in turn, is making sustainability issues more prominent on company agendas. An organization is now more responsible for the well-being of its stakeholders due to the growing number of national regulations and international standards, which govern the organization's actions towards the environment, corporate governance, anti-corruption practices and others (Szekely and Kirsch, 2005).

Pressures from various stakeholders especially government regulators, community activists and non-governmental organizations etc along with organizations own challenges has made it more pertinent that that the supply chains of organizations worldwide commit to practices of sustainability. As Hassini et al envisage that stakeholders like consumers, retailers, OEMs may demand products which are considered environmentally friendly from their suppliers. In addition, financial stakeholders such as mutual funds and pensions funds require that the company follow sustainable practices as described by them or some third party. Furthermore, in the future access to capital markets may be restricted only to businesses that are deemed to be ethical or environmentally friendly. Policy and regulations factors come from governments either through legislation or via a regulator requiring that companies adhere to certain environmental standards. The social issues factor focuses more on the existing behavior and practices of companies in relation to the treatment of their labor force, sourcing practices and environmental impact on their communities (Hassini et al 2012).

Thus, as a response to include sustainability in the current practices of an organization, there has been an effort to establish sustainability indicators and metrics. As performance measures and metrics will facilitate a more open and transparent communication between people, leading to a co-operative supported work environment and hence improved organizational performance (Gunasekaran and Kobu, 2007).These indicators and metrics are extremely important for an organization because they help to take right decisions at the right time.

Measuring sustainability also becomes important in the business context because measurement makes management easy. It helps to quantify current practices and provides the scope for improvement because as per Kaplan (1990) - 'no measures, no improvement'.

But there is no common standard for evaluating sustainability initiatives (Searcy et al, 2009 &Hassini et al, 2012). Although at global level, certain indicators such as Global Reporting Initiative – GRI (GRI, 2002), The Sustainability Metrics (IChemE2005), the Dow Jones Sustainability Index (Jones, 2005) and the OECD guidelines for multinational enterprises (OECD, 2005), ISO 14000 (ISO 14000) etc are used for gauging sustainability at an organizations and national level, but there is a lack of standardization of metrics for measuring sustainability at supply chain.

Lack of metrics for measuring supply chain sustainability is due to due to the inherent characteristics and nature of supply chain (Hassini et al 2012).Hassini et al emphasize that

1. Supply chain is dynamic as it needs to change with time in response to requirements.
2. There is a Difficulty in aligning strategies throughout the supply chain.
3. There is a difficulty in coordination of competencies.
4. Agreement and negotiations are necessary for consensus building to adopt sustainability initiatives.
5. There is a difficulty in co-ordination of competencies. The challenge within a supply chain context is that there could be redundancy in competencies and that the sum of the different parties' competencies may not be equal to the whole.
6. There are different partners and companies involved and hence difficulty in streamlining.

In alignment with this concept, the paper will attempt to

✓ Review the literature and current practices of organizations (irrespective of the business they are into) in supply chain management to outline the metrics and indicators that are used.
✓ Study the approaches suggested by other researchers.
✓ Highlight the gaps in the literature and approaches that needs further investigation

Papers are reviewed from journals and only those that catered to metrics/indicators in supply chain management are included. Metrics and indicators in the product and process side of supply chain management will also be reviewed.

2. Standard/Metrics in use

2.1 Discussion on Literature Review

2.1.1 Overview of metrics used

The concept of sustainability as an idea was coined in the World Commission on Environment and Development (WCED) Report (1987), also known as the Brundtland Report. The report attempted to articulate how sustainability was necessary to be regarded as the combination of environmental, economic and social factors. Seuring (2013) asserts that conceptualizing sustainability in three dimensions seems to be widely accepted .It allows an easy comprehension of the integration of economic, environmental and social issues.

Further, Beloff & Tanzil (2006) reason that the three dimensions of sustainable development has long been separately managed, and the significance of the concept primarily lies in the integration of various concerns. And the various metrics within each of three dimensions of sustainability have long been developed and used. Beloff & Tanzil (2006) point out individually for the measurement of these factors viz., the

environment, economic and social factors there are indicators such as Gross domestic product (GDP) per capita, literacy and poverty rates, concentration of air pollutants, return on investment etc used by countries and organizations worldwide.

Global agreements such as Agenda 21 and millennium development goals developed by United Nations Commission on sustainable development (UNCSD 2001) are instrumental in the development of metrics and indicators (Beloff & Tanzil, 2006). Such agreements influence policies of a nation and also make a road map for organizations to further their efforts towards sustainability.

Then, according to Stewart (2008), in an organization, metrics are broadly classified into absolute and intensity metrics.

- Absolute metrics are essential and are used to ensure that an organization is tracking to the goals, also called millennium goals, laid out by IPCC scientists for the year 2050.

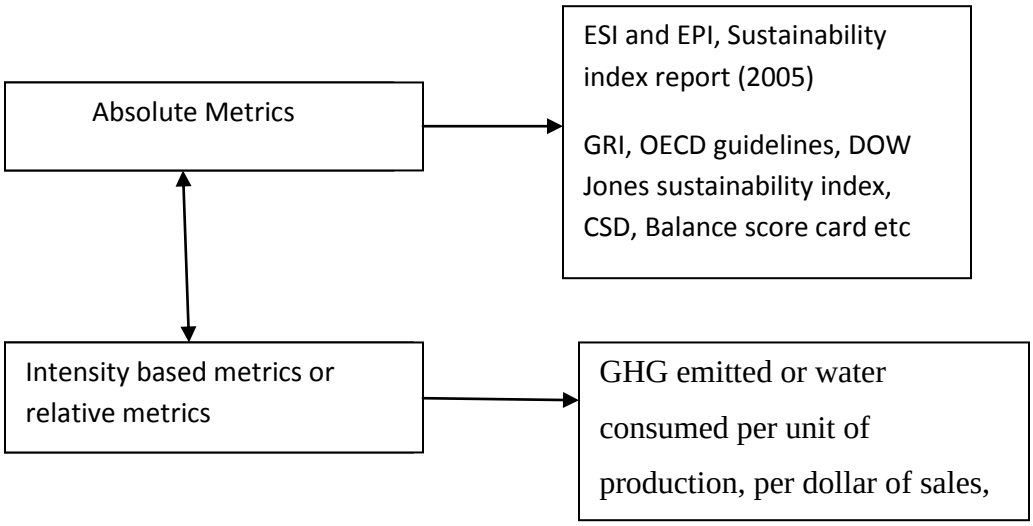
- Intensity metrics are needed and used for internal management analysis and allow managers to take appropriate and relevant decisions without constantly tweaking the baseline of millennium goals.

McElroy (2012) make it clearer by emphasizing that Absolute metrics express gross impacts by an organization during a defined period of time, such as total greenhouse gases (GHG) emitted or total water consumed in a year. Intensity or Relative metrics express performance in terms of some other variable of interest, such as GHG emitted or water consumed per unit of production, per dollar of sales, or per full-time-equivalent employees.

Absolute metrics are more relevant and used at the global level and national level. At organization's level, Global Reporting Initiative Index (GRI, 2002), the sustainability metrics (IChemE, 2005), the Dow Jones Sustainability Index (Jones, 2005) and the OECD guidelines for multinational enterprises (OECD, 2005) are used. At Global country level, as envisaged by WEF (World economic forum), some indicators are used for determining absolute metrics. Environmental Sustainability Index (ESI) is a composite index tracking socio-economic, environmental and institutional indicators that characterize and influence environmental sustainability at the national scale. The 2005 ESI report, published at the World Economic Forum's Annual Meeting in Davos(Switzerland), ranked 146 countries in order of the environmental sustainability of their past, current, and projected socio-economic and institutional development trajectories ESI (2005). The ESI acts as a precursor to Environmental Performance Index (EPI), which works at government policy levels to gauge environment public health and ecosystem vitality with regards to the global millennium goals aligned to reduce carbon emissions. The Sustainability Index Report (2005) presents a comprehensive set of variables and has identified seventy six indicators (or variables) grouped under five major components: environmental systems, reducing environmental stresses, reducing human vulnerability, social and institutional capacity and global stewardship.

Separate file provided

Figure 1: Broad Classification of metrics



2.1.1 The Indicators

1. Commission on Sustainable Development (CSD): The United Nations Commission on Sustainable Development (CSD) was established by the UN General Assembly in December 1992 to ensure effective follow-up of United Nations Conference on Environment and Development (UNCED), also known as the Earth Summit. Its objective is to make indicators of sustainable development accessible to decision-makers at the national level by defining them, by elucidating their methodologies and by providing training (Commission on Sustainable Development, 2002). It is an initiative that follows the Brundtland report concept of sustainable development and focuses on four dimensions of sustainability: social, environmental, economic and institutional.

2. The Dashboard of Sustainability: Developed in 1998 by the Consultative Group for Sustainable Development Indicators, it is an index of sustainability that uses a "Dashboard", a graphic interface, to display the country's performance towards sustainable development. The dashboard is divided into four dials labeled to the dimensions of sustainability and its main advantage is that it shows the overall sustainability of a nation in an easy way and also envisages the performance of each dimension of sustainability (Dashboard Sustainability).

3. The Barometer of Sustainability: Developed by The World Conservation Institute (IUCN), barometer measures sustainability at local, regional or national levels via a performance scale of human and environmental factors (Prescott-Allen, 2001).

4. The Global Reporting Initiative (GRI). It is a voluntary framework for reporting on an Organization's economic, environmental and social performance. Launched in1997 by the Coalition for Environmentally Responsible Economies (CERES) and the United Nation Environment Program (UNEP), it intends to help companies and their

stakeholders to understand and communicate their contributions to sustainable development and also provides guidelines for improving the quality and utility of sustainability reports. As envisaged by Elkington et al 1999, GRI focuses on the triple bottom line concept by balancing the complex relationships between current economic, environmental and social needs in a manner that does not compromise future needs (GRI, 2002). This framework is used widely by organizations to report their sustainability.

5. The Sustainability Metrics of the Institution of Chemical Engineers (IChemE): These are the sets of indicators developed to measure sustainability performance of process industries. According to this initiative, sustainability can be summarized in the triple bottom line covering the three components – environmental responsibility, economic return (wealth creation), and social development (IChemE2005).

6. The Dow Jones Sustainability Index (DJSI): It was established to track the performance of the top 10 percent of companies in the Dow Jones Global Index that lead the field in terms of corporate sustainability (Jones 2005). According to this index, sustainability means "to create long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments" (Jones 2005).

7. The Triple Bottom Line Index (TBL). This is an aggregate index that assesses sustainability performance of companies. It is the balance between financial growth, ecological improvement, and ethical equity (Elkington et al 1999).

8. ISO-14000: According to the ISO standards, ISO 14000 family addresses various aspects of environmental management. It provides practical tools to companies and organizations looking to identify and control their environmental impact and constantly improving their environmental performance. ISO 14001:2004 and ISO 14004:2004 focus on environmental management systems. The other standards in the family focus on specific environmental aspects such as life cycle analysis, communication and auditing (ISO 14000).

Along with these standards, there are various approaches suggested by researchers and used by organizations to deduce the various aspects of sustainability.

1) Life cycle assessment: It is a key method for evaluating the environmental impact of products on a cradle-to-grave basis. (Frankl and Rubik 2001). According to Linton a et al (2007) (as cited in Rebitzer et al. 2004; Pennington et al. 2004), life cycle assessment is used to assist in the determination of how to design a product to minimize its environmental impact over its useable life and afterwards (cited in Karna and Heiskanen 1998). This field is at the interface of engineering and product design that takes into consideration the resource depletion as well as environmental impacts.

2) Balance Score card: The balanced scorecard is a strategic management system that links performance measurement to strategy using a multidimensional set of financial and nonfinancial performance metrics. Using this card, organizations identify a variety of employee, operational, customer, and financial metrics as key performance

indicators to measure social and environmental responsibilities (Epstein and Wisner 2001)

3) Recycle-reuse: Sikdar (2007) asserts that each process and every product development should be under scrutiny to find ways for satisfying sustainability constraints. Recycling of products/materials for re-use will lead to optimal process design. He concludes that industrial ecology can act as an integrative approach in which process plants are designed to consume wastes in order to convert that waste into beneficial products.

4) Ecological footprint analysis: It is used as a tool to measure and analyze human natural resource consumption and waste output within the context of nature's renewable and regenerative capacity (Sezekely and Knirsch, 2005).

5) Hierarchical Metrics: According to this approach, environmental goals are achieved when one goal at management level is related to several goals at operation level. So, if the management goal is to achieve 25% reduction in fossil fuel use, the corresponding metrics will flow down to operational level to meet the criteria. (Graedel and Allenby 2002).

Along with the above metrics and indicators that are used by the organizations, there are few other approaches suggested by different authors. Michelini and Razzo (2004) suggested KILT model to determine sustainability using TYPUS, which stands for tangible yield per unit of service to assess resource decay. According to the authors, TYPUS metrics can provide critical means to manage product life cycles along with the measures of resulting environmental impact.

Some researchers focus on the process that manufactures products in order to establish sustainability indicators. Sikdar(2007)emphasized that industrial ecology in the process development should be given lots of importance so that the developed process converts waste into useful products and performs a life cycle assessment of process, simulation, scaling etc to help the engineers. Engineering needs to consider the interaction amongst industrial processes, human and ecological systems and LCA can help here (bakshi and Fiksel2003). Linear programming is also used in life cycle assessment for measuring sustainable supply chain (Chaabane et al 2012)

Azevedo a, et al (article in press) suggests an Ecosilient Index to assess the greenness and resilience of automotive companies and their corresponding supply chains. An integrated assessment model is proposed based on green and resilient practices. Delphi technique is used to obtain the weights of the supply chain paradigms that are focus of the study and of the corresponding practices.

Delai and Takahashi (2011) suggest that three aspects of sustainability can be measured more appropriately if the metrics are embedded in the performance management system of an organization. Some firms are also calculating sustainability via performance in form of accounting. From a cost accounting point of view, the approaches that are used have an integrated framework of economic value added (EVA), balanced scorecard (BSC) and activity-based costing (ABC) to measure supply chain performance. (Yao and Liu 2006)

McElroy (2012) further elaborates another type of metrics apart from the conventional: absolute and relative metrics. The third type is described as context-based metrics

(CBMs).Absolute metrics such as the emission of total greenhouse gases (GHG) or consumption of total water consumed in an year, express gross impacts by an organization during a defined period of time. Relative metrics such as emission of CHG or consumption of water per unit of production, per dollar of sales, or per full-time-equivalent employees, express performance in terms of some other variable of interest used. Context-based metrics differ from absolute and relative metrics in that they express performance relative to contextually relevant social or environmental thresholds. CBMs dictate, for example, that GHG emissions be measured against limits in the Earth's carrying capacity to absorb them without putting the climate system at risk; that water consumption be measured against the finite limits of renewable supplies; and that other impacts be measured against thresholds of their own kinds — including social ones, too.

3. Limitation/Gaps of Sustainability Metric in Literature review

Gunasekran et al 2007 in their review concluded that there was no sustainability indicators measures in 27 major performance measures in supply chain management that were identified in the literature. There is a scarcity of research on this subject (Gunasekran et al 2004).

Hassini et al (2012) concluded in their literature review that no study comprehensively address the three dimensions of sustainability in supply chain management. Some studies focus on environment, other on social aspects and some on economic aspects of sustainability. This is further verified as Delai and Takahashi (2011) assert that there is not even a single analyzed initiative that tackles all the sustainability issues. According to authors, in fact there is no consensus around what should be measured and how. The main divergences are related to the following aspects:

- Different criteria are applied by the initiatives to classify issues between dimensions;
- Same impacts are evaluated at different levels of a cause-effect relationship continuum by the same initiative,
- Disagreement on the groups of stakeholders a company should engage with.
- And assessment on the company's impacts that should be taken into account. Delai and Takahashi (2011)

Hassini et al (2012) further assert that there is no shortage of environmental indicators

- but no clarity on which one to use and when,
- no consensus on metrics in different supply chains,
- incompatibility between classical production measures,
- lack of oversight agency which controls the supply chain,
- lack of trust that leads to difficulties in aligning strategies,
- difficulty in coordination,
- Difficulty in streamlining the metrics due to the dynamic nature of the supply chains.

Beloff & Tanzil (2006) further point out that metrics developed and used currently focus primarily on the material and the energy flows. There are also additions of potential impact such as toxicity potential as a part of standard metrics. But the extension of this approach to supply chain, life cycle, broader sustainability considerations is limited, especially in progress tracking and management decision

making. This is primarily due to difficulty in obtaining data relative to company's own resource use and environmental release data in supply chain.

Researchers also concluded that research for sustainability issues is identified in every recent study on engineering research (Bakshi and Fiksel cited in Pfister and AC-ERE 2003; NRC-BCST, 2003). But the challenge is that it has a broad spectrum and integrates social, environmental and economic aspects of technology and human activity.

The research for sustainability metrics should take into account the limitations/gaps reported in literature which needs assimilation and research for determining, adopting and concluding the sustainability metrics in supply chain management.

4. Suggestions for further research

According to Szekely, knirsch (2005) there has been lot of progress in determining the environmental impact but the performance of environmental assessment is limited in determining the impact. The assessment of environmental performance is limited to natural resource depletion, land degradation, pollution, emissions and waste generations and not on the long term impact of the organization's operation.

Sezekely & Knirsch (2005) further assert that the biggest drawback of metrics remains is that the companies don't understand what to do with the emission and natural resources data that they are generating in line with the international standards. And the review of sustainability reporting done by GRI guidelines shows that organizations differ greatly in terms of scope and range of what is measured and reported. And hence this needs wider research by academicians and industry practitioners.

Different kinds of models are applied to measure economic and environmental effects in supply chain management; it is evident that the social side of sustainability is not taken into account (Sezekely & Knirsch, 2005). Hence, the sustainability metrics should utilize social along with environmental aspect of sustainability that should deduct the impact of organization's operations on long term sustainability. An organization should be able to profile the risk and sustainability issues as leading indicators to make more informed choices and metrics for supply chain management should go further to report on the risk profiling and costing of the decisions.

There are also suggestions for a concept called preference index. Sustainability metrics and specific indicators are useful tools but their utility in making project choices and policy decisions remain limited. Consequently, an exploration of superimposing concepts related to preference index is suggested to deduce and decide between multiple projects and decisions. This way, making project choices and making policy decisions can provide a more comprehensive framework and can help address multiple objectives and competing priorities related to sustainability. (Jain 2005)

Moreover , Context-based metrics which differ from absolute and relative metrics in that they express performance relative to contextually relevant social or environmental thresholds, needs more research for its adaptability to supply chain dynamism and respective organization operations and strategy. CBMs dictate, for example, that GHG emissions be measured against limits in the Earth's carrying capacity to absorb them without putting the climate system at risk; that water consumption be measured against the finite limits of renewable supplies; and that other impacts be measured against thresholds of their own kinds — including social ones, too. (Mc Elroy 2012).

The approach needs to be verified and evaluated at different levels within an organization for it approach, adaptability and usage with respect to sustainability.

4.1 Metrics/Indicators should include following criteria as well

According to Olugu et al (cited in Handfield and Nichols 1999), green supply chain management should address three interrelated task areas i.e. upstream, internal stream and downstream of the organization. Upstream of organization's supply chain involves the inclusion of environmental criteria in the evaluation and selection of suppliers and in the specification of the components. The internal stream will be concerned with operations within the manufacturing company itself. Downstream of the organizations supply chain should be charged with the responsibility for disposal and sale of excess stock, including opportunities for after recovery and recycling of materials.

The Yale Center for Environmental Law and Policy report (Environmental Sustainability Index 2005) suggests that sustainability is a characteristic of many dynamic systems. These systems maintain themselves overtime and should not be viewed as a fixed endpoint. Thus, environmental sustainability refers to the long term maintenance of natural resources and the environment in a dynamic human context. We, then, have to recognize that metrics used for sustainability have to respond to the interconnectivity and temporal variations as well.

According to Gopal and Thakkar (2012), it can be summarized that the supply chain metric/sustainability developed should have some of the following characteristics:

1. Metrics should be able to handle supply chains for long and short product life cycles.
2. Metrics can have classification based on push, pull and push-pull supply chains.
3. Metrics and performance system/model should be mathematically valid.
4. Cross functional fit of metrics across industries.
5. Measures for addressing the continuous improvement in metrics.
6. Tailoring the measures for complex supply chain networks in present network era.
7. Metrics should have the ability to help organization to understand and respond to the rapidly changing value addition curve.
8. Ability of KPIs to handle assorted supply chain collaborations and partnerships.
9. Competitive environment demands empirical measures and case study approaches for measuring the supply chain.
10. Extent to which organizations classify the metrics based on long and short term strategies of supply chains.

5. Conclusion

Sustainability is critical to conserve resources for future use. The drastic climate changes, emissions, waste generation, land degradation and population explosion have added enormous pressure on available resources. The sustainability initiatives can help organizations to assess environmental impact along with social and economic impact of an organization's operations. At an organizational level, supply chain plays the most important role as it encompasses the material and information flow across all the levels in an organization. Metrics, standards and indicators are needed and used to gauge nation's policies, organizational operations and its choices. They help managers/policy makers to make informed decisions. Some standards and metrics are

globally available to help nations frame policies in order to attain the millennium goals in quest for development. Some standards and metrics are also used by the organizations to report their sustainability initiatives.

But there is a lack of standardization of metrics for measuring sustainability at supply chain.

The measurement of sustainability for supply chain is not done due to the complexity of supply chain, its dynamic nature and above all lack of clarity and consensus on metrics. Thus it is difficult for organizations to suggest solutions using the available data and generated information. The metrics and standards need to be improved and refined to help channelize the efforts that organizations are making to become more sustainable.

Research is needed in the area of sustainability metrics in supply chain to overcome the reported drawbacks/limitations, primarily, there should be

- clarity on which one kind of metric to use and when,
- consensus on metrics in different supply chains,
- compatibility between classical production measures,
- Removal of lack of oversight agency which controls the supply chain,
- Removal of lack of trust that leads to difficulties in aligning strategies,
- Reducing the difficulty in coordination,
- Reducing the difficulty in streamlining the metrics due to the dynamic nature of the supply chains.

The reported metrics/indicators should be spread across the organization, should be frequently collected to allow timely corrections and the performance should be compared to starting point as a reference. The metrics/indicators should be audited externally, compared internally and externally, should be user friendly and meaningful, should balance cost/benefits in measuring/reporting to accomplish results.

6. References

Ashby, A, Leat, M., Hudson-Smith, M, 2012. 'Making connections: a review of supply chain management and sustainability literature. Supply Chain Management':

An International Journal, vol 17 , no. 5, pp no. 497-516.

Azevedo ,S G. ,Govindan , K &Carvalho, H, Machado, V. C article in press, 'Ecosilient Index to assess the greenness and resilience of the upstream automotive supply chain', Journal of Cleaner Production(Article in press)

Bakshi, B.R and Fiksel, J 2003, 'the quest for sustainability: challenges for process system engineering' *AIChe Journal,* vol 49, no.6, pp 1350-1358

Chaabanen,A, Ramudhin , Paquet,M2012, 'Design of sustainable supply chains under the emission trading scheme', *Int. Journal of Production Economics*, vol 135, pp 37–49

Commission on Sustainable Development (2002), 'Indicators of sustainable development: guidelines and methodologies', viewed 20 August 2013, < www.un.org/esa/sustdev/csd.html >

Delai, I and Takahashi, S 2011, 'Sustainability measurement system: a reference model proposal ', *SOCIAL RESPONSIBILITY JOURNAL*, vol 7, no.3, pp 438-471

Dowse, J. 2005, 'Making CR measurement meaningful to the rest of the business', Corporate Responsibility Management, vol. 1, no. 6, pp. 14-21.

Elkington, J. 1999, 'Triple bottom line revolution: reporting for the third millennium', *Australian CPA*, vol. 69, no. 11, pp. 75-7.

Environmental performance index, yale university, viewed 21 August 2013 <http://epi.yale.edu>

Environmental Sustainability Index (ESI), 2005, Yale Center for law and environmental policy, viewed 21 August 2013 <http://envirocenter.yale.edu/?page=environmental-sustainability-index>

Ernst and Young 2013, *2013 six growing trends in corporate sustainability report*, Ernst and Young, United States of America

Frankl, P & Rubik, F 2001, 'LIFE CYCLE ASSESSMENT IN INDUSTRY AND BUSINESS: ADOPTION PATTERNS, APPLICATIONS AND IMPLICATIONS' *Bus. Strat. Env.* Vol**10**, pp. 252–255

GRI 2002, 'Sustainability reporting guidelines', Viewed 20 August 2013 : <www.globalreportinginitiative.org >

Graedel, T.E &Allenby, B.R 2002,'Hierarchial metrics for sustainability', *European quality management,* winter 2002 viewed 23 august 2013 <www.interscience.wiley.com, DOI: 10.1002/tqem.10060).

Goodland, R & Daly, H 1996,'Environment sustainability-Universal and Non-negotiable', *Ecological Applications, v*ol. 6, no. 4

Gupta, S &Palsule-Desai,O 2011,' Sustainable supply chain management: Review and research opportunities', *IIMB Management Review*, vol 23

Gunasekaran, A., Kobu, B., 2007. 'Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995–2004) for research and applications', *International Journal of Production Research*, vol 45 (12),pp 2819–2840.

Gunasekaran, A., Patel, C., McGaughey, R.E., 2004. 'A framework for supply chain performance measurement', *International Journal of Production Economics*, vol 87 , no.3, pp 333–347.

Hassini, E., Surti, C., Searcy, C 2012, 'A literature review and a case study of sustainable supply chains with a focus on metrics' ,*Int. J. Production Economics*, vol 140 ,pp 69–82

IBM, 2009, *Sustainability on a Smarter Planet: Going Green and Beyond,* IBM viewed on 10 feb 2014 < http://www-935.ibm.com/services/us/gbs/bus/html/environmental-operational-sustainability.html >

IChemE 2005, 'The sustainability metrics', viewed 21 August 2013 <www.icheme.org>

ISO 14000, 'Environmental management', viewed on 25 august 2013 <http://www.iso.org/iso/home/standards/management-standards/iso14000.htm>

Jain, R 2005, 'Sustainability: metrics, specific indicators and preference index', *Clean Technology Environ Policy*, vol 7, pp 71–72

Jones, D. (2005), 'Dow Jones sustainability world indexes guide v. 7.0', viewed on 12 August 2013 < www. sustainability-indexes.com>

Kaplan, R.S. (Editor). Measures for Manufacturing Excellence, 1990 (Harvard Business School Press: Boston, MA).

Linton a, J.D, klassen b, R, Jayaraman,V 2007, 'Sustainable supply chains: An introduction', *Journal of Operations Management* , vol 25,pp 1075–1082

McElroy, M 2012, Groundbreaking Study Reveals Shortcomings of Conventional Sustainability Metrics, viewed 20 August 2012 <http://www.sustainablebrands.com/news_and_views/new-metrics/groundbreaking-study-reveals-shortcomings-conventional-sustainability>

Michelini, R.C and Razzoli, R.P 2004, 'Product-service for environmental safeguard: a metrics to sustainability', *Resources, Conservation and recycling*, vol 42, pp 83-98

OECD 2005, 'Measuring sustainable development: achievements and challenges', paper presented to Conference of European Statisticians, Statistical Commission and Economic Commission for Europe, United Nations, Geneva

Olugu , E U, Wong ,K Y, Shaharoun , A M 2011, 'Development of key performance measures for the automobile green supply chain', *Resources,Conservation& Recycling*, vol. 55, no. 6, pp 567-579

Prescott-Allen, R. 2001, The Wellbeing of Nations: A Country-by-Country Index of Quality of Life and the Environment, Island Press, Washington, DC.

Schwarz,J,Beloff,B&Beaver,E 2002,' Use Sustainability Metrics to Guide Decision-Making',cepmagazine viewed 5 May 2013 <www.cepmagazine.org>

Searcy, C., McCartney, D., Karapetrovic, S., 2007 'Sustainable development indicators for the transmission system of an electric utility'. *Corporate Social Responsibility and Environmental Management, vol14*, no. 3, pp no. 135–151.

Seuring , S, 2013,' A review of modeling approaches for sustainable supply chain management'. *Decision Support Systems*, *vol* 54, pp no. 1513–1520

Stewart, E 2008, Building Better Sustainability Metrics viewed 27 August 2013 <http://blogs.hbr.org/leadinggreen/2008/09/building-better-sustainability-metrics.html>

Sikdar, S K. 2007, 'Sustainability and recycle–reuse in process systems', *Clean Techn Environ Policy*, vol 9, pp no. 167–174, viewed 23 august 2013, < DOI 10.1007/s10098-007-0087-6 >

Szekely, F & Knirsch, M 2005, 'Responsible leadership and Corporate Social responsibility: Metrics for Sustainable performance', *European Management Journal,* vol 23 no. 6, pp 628-647

Tanzil, D ,Beloff ,B R 2006 ,'Assessing impacts: Overview on sustainability indicators and metrics', Wiley Periodicals, Inc viewed 19 July 2013 <DOI: 10.1002/tqem.20101>

The Dashboard of Sustainability, Viewed 20 August 2013, <http://www.iisd.org/cgsdi/dashboard.asp>

United Nations Commission on Sustainable Development2001.'Indicators of Sustainable development: Guidelines and methodologies' viewed 12 July 2013

<http://www.un.org/esa/sustdev/natlinfo/indicators/isdms2001/isd-ms2001isd.htm>

United nations 2011, the *future we want* viewed on 10.feb.2014 <http://www.un.org/en/sustainablefuture/sustainability.shtml>

WCED (1987), Our Common Future, Oxford University Press, Oxford

Yao, K. and Liu, C. (2006), 'An integrated approach for measuring supply chain performance', *Journal of Modern Accounting and Auditing*, vol. 2, no.10, pp 17.