Best Practices in Green Supply Chain Management

A Developing Country Perspective

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List of Abbreviations

AHP	Analytical Hierarchy Process
ANOVA	Analysis of Variance
ANP	Analytical Network Process
BD	Benders Decomposition
BSP	Benders Subproblem
CAGR	Compound Annual Growth Rate
CB-SEM	Covariance-Based Structural Equation Modelling
CC	Collection Centers
CDC	Central Distribution Centers
CENACE	National Center for Energy Control
CER	Certified Emission Reduction
CFA	Confirmative Factor Analysis
CFE	Federal Electricity Commission
CO_2	Carbon Dioxide
DEMATEL	Decision-Making Trial and Evaluation Laboratory
DS	Disposal Site
EEP	External Energy Producers
EMS	Environmental Management System
EPC	Electric Power Supply Chains
FAHP	Fuzzy Analytical Hierarchy Process
FDI	Foreign Direct Investment
GHG	Greenhouse Gas
GL	Green Logistics
GP	Green Procurement
GSCM	Green Supply Chain Management
GTMA	Graph Theoretic and Matrix Approach
ISM	Interpretive Structural Modelling

JIT	Just in Time
LB	Lower Bound
LED	Light Emitting Diode
LP	Linear Programming
MIP	Mixed-Integer Programming
MP	Master Problem
MSME	Micro, Small, Medium Enterprises
NCR	National Capital Region
NGO	Nongovernment Organization
NOIDA	New Okhla Industrial Development Area
PLS-SEM	Partial Least Squares Structural Equation Modeling
RC	Recycling Center
RDC	Regional Distribution Centers
RL	Reverse Logistics
RMP	Remanufacturing Plant
RPC	Reprocessing Center
SAP-LAP	Situation Actor Process–Learning Action Performance
SCM	Supply Chain Management
SCND	Supply Chain Network Design
SD	Sustainable Development
SDG	Sustainable Development Goal
SEN	National Electricity System
SSCM	Sustainable Supply Chain Management
TBL	Triple Bottom Line
TCIL	Tire Corporation of India Limited
UB	Upper Bound
UNDESA	United Nations Decade of Education for Sustainable Development
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNGC	United Nations Global Compact
UNHABITAT	United Nations Human Settlement Program
WCED	World Commission on Environment and Development

Preface

Developing countries are looking for alternate paths to sustainability as the problems faced by them are region, social, and culture specific. They look forward to relevant and affordable ideas emerging from developed nations for inspiration and other developing nations who are facing similar challenges on economic, social, and climatic fronts. They are contriving methods and ways to compensate growth with economic utilization of resources, implementation of energy-efficient technologies for progressive reduction of carbon intensities for sustainable development. But a bigger question worth asking is: is this development sustainable in a real sense? It is an accepted fact that the paradigm of sustainable development is primarily focused on environmental and economic development, and the agenda of social development needs to be reconsidered. The dilemma faced by a majority of nations is profit versus conservation, and since it is a debatable issue, we have examined some antecedents of the concepts of sustainable development and narrowed down key points from the debate which are worth pondering over for their validity, suitability, and accountability toward the issues and challenges of sustainability. The sustainable development definition given by the *Brundtland Report* and its related controversies and shortcomings and further additions to the concepts are also discussed for comprehension and interest of our readers. The areas left uncovered in the initial definition of sustainable development – place and people – have provided us the motivation for directing our effort toward human issues in sustainable development with a focus on place aspect developing countries. The role played by the United Nations, the programs initiated by them, and the work done by various academicians, societies, and global or international bodies have been highlighted for understanding the complexities and challenges related to sustainability. The exponential growth and evolution of a supply chain is described by uncovering multiple theories and reviews proposed by academicians and global researchers. The book also covers the issues associated with green supply chains and sustainable supply chains by first outlining their fundamental differences and then discussing their contribution toward the agendas of sustainable development, with comprehensive details about the practices, pressures, and major drivers. The major drivers of green chains are internal, external, and regulatory, and the main drivers of sustainable supply chains are similar to green chains with the inclusion of social drivers. The popular practices for greening the supply chain and for sustainable supply chains are also discussed in detail. The book proceeds with a holistic and inclusive discussion on the methods of measurement of sustainability: quantitative mode as an objective

measurement relying on statistical, mathematical, or numerical analysis or primary data collected through a medium of polls, surveys, questionnaires, etc.; qualitative mode that is subjective in nature and focuses on images, transcripts, and words. Comprehensive discussions and research work done in multivariate analysis and its relevance to the context of supply chain, identifying its related problems and offering solutions for emission reduction adds to the richness of the book. Using statistical methods researchers have attempted to quantify the relationship among variables of supply chains to predict the likely outcomes in the form of a comprehensive research study based on combined qualitative and quantitative assessment of green supply chain practices adopted by the Indian manufacturing sector. The study applies the regression techniques to help in calculation of coefficient for each independent variable of the supply chain to estimate the effect of each predictor on independent variables. Regression further provides insights to the researchers by calculating statistical significance and quantifying relationships between predictors and outcomes, which helps them in making practical and viable decisions concerning supply chain efficiencies. The book provides insights into the complex problem and sustainable approaches of electricity generation in developing nations like Mexico for practitioners and business managers. Outlining a connection between inventory levels of fuels in thermal plants and their transport medium, a study is presented using Delphi techniques for charting policies for carbon reduction. For keeping the interest of readers alive we took the liberty of including interesting case studies from Indian organizations, covering varied fields of sustainable HRM practices, reverse logistics, and emission control measures from the tire industry. Among the existing theories and concepts the one which excites us is the application of Optimization and Operations Research for designing and controlling complex systems, solving hard problems of efficiently allocating scarce resources using incomplete information, and developing sustainable strategies to master situations of conflict and co-operation in a scientific manner. The final chapter covers Mixed Integer Linear Programming and *Mobile6* software methodology and Benders Decomposition to counter the demand uncertainty in the supply chain in the Mexican context.

Relevance of the Study

The study of Environmental Management and Sustainability has experienced a gradient shift from a niche area to mainstream way of thinking and education. It has evolved from philanthropic discourses on Save Earth or Save the Planet to a broader discipline providing insights into the aspects of environment studies, social sciences, business and technology to a wider range of participants including students, economists, environmentalists, world leaders, and the community at large. Since the modern world is struggling with issues of environmental sustainability, "sustainability" education concentrates on core skills and capabilities which are suitable for handling environmental complexities through innovation in technology and science, social and political norms. Sustainability has its roots in politics, economics, philosophy, social sciences, but it also covers a broader theoretical spectrum of civic engineering and technology, so its education and applications are pertinent to many fields like civic planning, environmental

consultancy, agriculture, corporate strategies, health care, and many more related fields. The book covers the sustainability and sustainable development concepts from multiple viewpoints and offers comprehensive qualitative and quantitative research focuses which can offer insights to a variety of readers, including students, academicians, supply chain managers, social groups, and researchers. Rising cost of manufacturing, shrinking resources of manufacturing bases, coupled with the problem of shortened life cycle has pressurized supply chains to find alternate routes, and green supply chains have started to play their part well. The book is also a good read from a green supply managerial perspective since elaborate discussion about the practices and drivers of green supply chains have been covered.

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Chapter 1

Sustainable Supply Chain Management

SECTION I

1.I.1 Introduction

Human existence visualized from a collective as well as individual perspective appears to be a natural rather than a contrived phenomenon, which has been aligning its growth patterns to the everlasting and evolving social, ecological, cultural, and economic processes. It has traversed from "Conventional to Contemporary" and "Individualistic to Materialistic" approaches to find a firm and cohesive entity in the modern world by virtue of living practices and approaches which are conducive to its own viability or sustainability and nourishment of its natural environment. As stated by *Hans Meltofte (2013)*, "*There is no inherited capacity in human nature to safeguard the earth's biological assets-moral and intellectual strengths are needed to achieve conservation and wise use of living resources through cultural and personal ethics and practices*." By integrating nature into their socioeconomic cultures, resources lifestyle, and survival ethos, humans have managed to establish coexistence and connectedness with nature. For ages they have survived though the thick and thins of their environmental complications, but the modern world is posing some serious threats to their existence. Why so?

Experts share divergent opinions about the modern world; one opinion believes that the modern civilization is characterized by separation, scarcity, struggle for survival, and materialism, feeding on individual's identities, greed, and hunger for power; the other opinion believes that the modern civilization is in the phase of transition as result of awakened consciousness of the human mind which continually seeks harmony and peace with its surrounding environment (Ali, Kaur, & Jaramillo, 2018).

In light of these statements, we analyze these two contradictory worlds; the materialistic world encounters shocks and stresses due to continuous degradation of the environment, global warming, and indifferent and careless consumption, thereby threatening livelihoods and natural ecosystems. There is no contradiction in the fact that climate change and human activities together contribute to the decline of earth's natural habitat, and there is no such term as static environment or limitless supply of natural resources, so here we have cause to worry. It clearly means that human activities should conform to a standard of functionality which aims to increase the inherent potentials of an ecosystem to generate, sustain, and evolve not only the feasibility and growth for the lives in a place but also their sustainable continuity. But reality is far

from this notion. As we know, increasing globalization, industrialization, growing international trades, and evolving customer's demand drive the production and consumption patterns upward, and these factors exert anomalous pressures on the working capacities of organizations worldwide, and consequently organizations stretch their existing capacities to compensate for this ever-increasing demand. Financial incentives are far more tempting and lucrative than environmental incentives, so bypassing environmental ethos and agendas eventually leads to the decimation of the natural environment. Loose and nonuniform regulations further add to the intensity of the problem. Instances of environmental damage by human civilizations are ample and can often also be traced to many literary works as mentioned by *Jared Diamond (2005)* in his book, *Collapse: How Complex Societies Choose to Fail or Survive.* Globally, organizations speak about sustainability and sustainable practices in their business operations, their corporate strategies, and alternately the ideas of bigger profits and phenomenal growth also appeal to them strongly. It is evident beyond any doubt that in this materialistic modern world, "*margins are earned at the cost of the environment*."

Alternatively, the opinion about a different world, which is founded on the "principles of sustainability" and has environmental concerns at its forefront, offers some hope to mankind. This world prefers to put environmental sustainability as a continuous and universally accepted reality and a combined responsibility of every human being on this planet.

1.I.2 What Is Sustainability?

> *Sustainability is something everyone can work towards… whether it is picking up garbage you see on the street or boycotting a company that practices environmentally harmful business methods, we all can make a difference.*[1]

Sustainability can be visualized as a concept, a development strategy, or an operating practice. Sustainability as a concept is an idea which guides our paths in a direction of how we might live in harmony with the natural world around us, protecting it from damage and destruction. It is tricky though as we strive to find balance between two competing needs; one favoring economic and technological advancements and the other prioritizing the environment.

Sustainability literally means capacity to endure or ability to be maintained at a certain rate and level. Different viewpoints can be found defining "sustainability" in their unique contexts; however, the original and most commonly cited definition of sustainability or sustainable development (SD) is

> *Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.* (Brundtland Report, 1987)[2]

1.1.2.1 Origin of the Term "Sustainability"

The United Nations, an intergovernmental body established after World War II, has been working toward promoting international economic and social cooperation and development and importance of human culture and science. It was during the year 1987 the environmentalist and development experts within the United Nations system coined the term "sustainable development" and gave the abovementioned statement in the landmark "Brundtland Report." The aim of this report was to find an alignment between two contrasting interests of environment stability and economic development. This statement also provided us the "three E's" of Sustainability: Economy, Environment, and Equality.[2] This report was responsible for the commissioning of UN program of Action on "*Sustainable Development*" which eventually led to the creation of the *UN Commission on Sustainable Development* after the *Rio Summit*[3] in 1992 with a purpose of increasing awareness about SD across various sectors and levels of human society. Significant international SD programs promoted by the United Nations are the *United Nations Development Program (UNDP)*,[4] *United Nations Environment Program (UNEP)*,[5] *and United Nations Human Settlements Program (UN-Habitat)*.[6] Several international congresses including the United Nations Conference on Sustainable Development (Rio 2012, Rio+20 or Earth Summit 2012) have been actively contributing toward SD with a continuous and strong commitment.

1.1.2.2 Three Pillars of Sustainability

(1) Environmental protection – minimization of negative impacts by sustainable production and consumption;
(2) Social development for equality;
(3) Economic development.

The accomplishment of development in these three core areas can be commonly termed as sustainable development.

Sustainable Development is defined as *"A process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations*"[7]

Expanding the concept further, in 2000, the *Earth Charter*[8] redefined this statement by adding ideas of global society centered on the themes of *"respect for nature, universal human rights, economic justice, and a culture of peace*."

The dimensions of SD cover three main areas starting from physical aspects, focusing on the use of natural resources in a manner which limits their degradation while maintaining their equation with nondeclining or renewable stocks of natural resources such as soil, groundwater, and biomass to keep them useful for future generations. The economic aspect of SD implies *maximizing the net benefits of economic development, subject to maintaining the services and quality of natural*

resource (Idowu & Kasum, 2013), which means there should be a balance between the *use of natural resources and real incomes in future.* Economic development clearly focuses on the fact that the use of natural resources should promote the inflow of future funds while stabilizing the quality of natural resources. The social development aspect relies on principles of good governance and covers broad areas of food security, equality, inclusive prosperity, sanitation, health, clean drinking water, and minimum living standard for all. We can say that SD aims to preserve the level of economic well-being for future generations while achieving a balance between human need and environmental needs of planet earth. The social development agenda, however, has remained the point of debates and discussion as many researchers believe that while economic and environmental dimensions have received required attention, social dimension has been left behind (Ashby, Leat, & Hudson-Smith, 2012; Carter & Liane Easton, 2011; Mani, Agrawal, & Sharma, 2016; Seuring, 2013; Seuring & Müller, 2008). The reason could be attributed to the fact that the definition of sustainability though covers the human need perspective; it is a broad statement and is generally interpreted in different manners, in the context of different countries. The real difference in SD achievement goals could be understood by going through the SD perspective in developing countries.

1.I.2.3 Issue of Sustainable Development in Developing Countries

For better understanding we would like to proceed with this concept from a different perspective; first, understanding development from the following viewpoints:

- *Feasibility* is the development in a given region; feasible constraints and challenges;
- *Affordability* is the development in a given region affordable; if so, at what cost?
- *Viability* is the strategies to retain the element of sustainability in development;
- *Relevance to the local context* is how much the sustainability programs fit in the local context.

While SD is considered as a perfect pathway for countries striving to deliver inclusive growth, eliminate poverty, and reduce the risk of climate change by changing perspectives and approaches, alternatively many researchers believe that it has become a glorified agenda or a metaphor for describing human welfare and environmental management (Cobbinah, Erdiaw-Kwasie, & Amoateng, 2015), especially in developing countries which are struggling for economic developments while maintaining practices and factors supporting environmental conservation. Critics have questioned whether economic development is possible without sacrificing environmental issues, especially in developing countries. Though developing countries are becoming sources of global economic growth, they still struggle to find solutions for energy, food, water shortages, and

unchecked use of natural resources. Developing nations attract investors and manufacturers who are on the lookout for cheap cost of production and labor in return for economic benefits for the host country. These countries have enough supply of raw material to fulfill the demand of enhanced production. Regional and political factors also play a major role in these income generating opportunities. As the world has turned into a global market, the demand for commodities are soaring every day, putting pressures on natural resources like industrial metals and fossil fuels. The growing demand of commodities brings infrastructural development to accommodate the manufacturing unit, warehouses etc., so this implies use of land and other infrastructural facilities, enhanced transportation, and more mobility of labor. This sometimes leads to concentration of industrial setups in confined localities which are not established historically for accommodating such burdens. These concentrated and confined places sometimes become the focal points of discussions among environmentalists and researchers who believe that the development which comes at the cost of health and safety cannot be termed as sustainable. This concept of sustainability is certainly debatable on the grounds of its longevity as well. For these similar reasons, the statement given by the World Commission of Environment and Development (WCED) has been criticized for its many limitation; first, it acknowledges that decisions related to economic development must be inclusive of environmental and social implications, but these somehow do not cover the "place" (Aygeman & Evans, 2003), "person" (WCED, 1987), and "permanence" (Adam, 1998) aspects. Development agendas should integrate the relevance of place in its context because place paradigm in development considers "*place-based models of nature, culture, and politics"* (Escobar, 2001). Nature is specific to a place and sometimes it becomes a symbol or landmark for a specific region, as we recall the valley of *Jammu and Kashmir*[9] has been popularly called as *the paradise on earth* because of its natural and scenic beauty. The features of a place describe the patterns of networks, mobility, and migration in it; *inward if favorable, outward if not* (Urry, 2002) Places are grounds for people's identities, behavior, way of life, and psychological health (Franquemagne, 2007; Garavan, 2007; Leff, 2000) and provide a sense of kinship, inclusion, and rapport to them (The five dimensions of sustainability). Concerns about another dimension of SD, which is, "*permanence*," have been highlighted by *Donald Worster (1993)* in his work, *The Shaky Ground of Sustainable Development*, when he states,

> *The first and perhaps most difficult problem, one that seldom gets addressed, is the time frame…Is a sustainable society one that endures for a decade, a human lifetime, or a thousand years?*

Time as mentioned by *Giddens (1984)* has relevance to *space, social institutions, and individual persons.* In his book *Five Dimensions of Sustainability,* Seghezz (2009) has stated that the *notion of sustainability should include personal dimension*. The UNDPs also stresses upon the fact that men, women, and children must be the center of attention–with development woven around people, not people around development.[4]

In the context of the above viewpoints, we would like to discuss the SD prospects in India.

1.I.3 Regional Factors of Industrial Growth

Industrialization in India had gained prominence because of its rich sources of raw material, supported by the availability of skilled and unskilled labor, production facilities, favorable government rules and regulations, transportation facilities, and connection with railways and highways. Climatic condition, ample water supply, good connectivity via national highways running throughout the country, major international airports in major cities providing international access, infrastructural connectivity, affordable housing options, cost-effective land acquisition plans in suburban areas in most big cities, presence of auto engineering and electrical industries, energy, automotive, and many more along with the booming IT sector in India are some of the compelling factors of industrial growth here.

1.I.4 Political Factors of Industrial Growth

The government had always pushed the industrial sector across India with its multiple numbers of schemes as the government believed that growth in the industrial sector impacted the gross domestic product in India.

When Mr Narendra Modi became the Prime Minister of India in 2014 he launched multiple schemes as a part of a wider set of nation-building initiatives of which Make in India[10] gained immense popularity. This initiative was a major cry for the Indian industrial sector to utilize the immense potential of its resources and to present India's strong "technical and innovative" and "manufacturing" image to the world. Mr Modi gave a major push to the entrepreneurship drive also and motivated people to go for their "startups." Multiple schemes were launched in "Startup Action Plan" in 2016 of which fund of funds and tax exemption became really popular.[11]

For better working of small and medium enterprises, the government had multiple schemes of which the Industrial Cluster development program, Micro Small Enterprise-Cluster Development program, Industrial Infrastructural Upgradation Scheme[3] were meant to promote industrial growth in established clusters like the Pune Nashik area as well as the new ones. Some of the government's financial and skill improvement schemes also gave a boost to the manufacturing drive like Pradhan Mantri Kaushal Vikas Yojana (PMKVY)[12] to open 1,500 multiskill institutes across the country. Allocation of 34.65 billion for the growth of micro, small, and medium enterprises and lowering the corporate tax rate for relatively small enterprises and tax saving schemes for new manufacturing companies all worked in the favor of industrial growth.

While these factors of industrial growth are favored because they provide economic benefits to our country bringing social equality and upliftment of poor sections of society with more funds and job opportunities, alternatively we

strongly believe that amidst the heat of the discussions of the delineations of social agenda like the upliftment of the poor, everyone seems to overlook and exploit the nature to their own advantage. Also, we would like to question if this industrial growth is bringing social equality and upliftment of poor in the real sense.

1.I.5 Environmental Concerns

Growth in technological, industrial, and agricultural advancement coupled with increases in population growth in this region had been contributing toward one of the major problems and that is the deterioration of environmental quality. Huge traffic jams in the main junctions creating fuel problems as more petroleum products got wasted, combustion of petroleum products, leading to increased level of carbon dioxide, increased waste production, and energy consumption, and lack of stringent environmental rules are adding to the problems of environmental sustainability.

1.I.6 Social Concerns

The growing urbanization and industrialization have raised critics' attention as they believe that population growth, limited awareness, and lack of education take less developed countries toward unsustainable consumption (Cohen, 2006). The issues of health, safety, sanitation, provision of clean drinking water, and living standards of the poor section of society, especially industrial workers and migrant laborers dwelling in slums in search of job opportunities in industrial areas, have remained an area of neglect. According to the United Nations Department of Economic and Social Affairs (UN DESA),[13] almost a third of the world's urban population, which is about one billion people, are living in slum settlements.[14] The slum dwellers are exposed to risk of toxic and harmful industrial waste, crime, social dysfunction, and a fragile, dangerous, or polluted environment and are often prone to serious health risks associated with poor sanitation, water quality, waste disposal facilities, and infectious agents. They also suffer from social isolations and do not have access to proper education and health care and barely meet their daily nutrition requirements (Riley, Ko, Unger, & Reis, 2007). Their living conditions pose a serious threat to their own existence as well as to the neighboring societies.

Clearly SD is a challenging and humongous task, especially for the developing countries which are facing elevated levels of ecological decay and great economic inequalities due to unsustainable growth, apathy of government, laxity in regulations, and many related issues. Handling this challenge requires continuous, productive, innovative, and concerted efforts to strike a balance between *survival for today and preservation for the future*. Sustainable practices are the requisite solutions, but these practices also need collective contributions, discipline, and common missions, as clearly stated by *Hans Meltofte (2013)*: "Sustainability is a prerequisite for such balance, but it does not come without restraint and concerted efforts by all stakeholders, supported by mutual pressure, legislation

and law enforcement." There is an immediate need for cohesive and inclusive approaches and collaborations on the part of the government in implementation of stringent regulations and policies and corporate policies and practices as well to overcome problems related to sustainability. As stated by Sneddon, Howarth, and Norgaard (2006):

> *While these obstacles are significant, how they might be overcome through a reinvigorated set of notions and practices associated with sustainable development, one that explicitly examines the linkages between sustainability policies and sustainability politics.*

1.I.6.1 Looking Forward: Sustainable Development Is Possible – How?

Scientists and environmentalists have been advocating sustainability in different manners First, we must understand that "We cannot just add sustainable development to our current list of things to do but must learn to integrate the concepts into everything that we do."[15] Sustainability should not only be a part of work, rather it should be the guiding principle and influence for work. Sustainability is not a one-man show, it is in fact a reflection of a consortium of mutual, collaborative, and synchronized efforts. As mentioned in the works of "*The Real-World Coalition of the World Commission on Environment and Development, 1996,*" *it is* "Integration of economic and environmental policy for improvement in income growth, reduction of poverty, and resource distribution is feasible and all sections of societies must be involved in decision making."[16] Also, it is important to note that there are just no similarities in human and ecological systems as humans exists on four limbs and sustainability rests on three limbs or pillars; it should be further understood that ecological and human systems are interdependent as both cannot survive in the absence of either system. Therefore, ecological systems must be protected for human survival and SD of its ecosystem.

1.I.7 Education for Sustainable Development

SD goals (SDGs) are achievable with a careful design of economic policies and business strategies which are aptly synchronized with development programs. Also, provision of information and guidance to people working in the field of adaptations, conservations, and development would enable or even empower them to design, implement, and monitor feasible and effective options for a sustainable future. As stated in the *UN Decade of Education for Sustainable Development (UN DESA) 2005–2014*:

"A sustainable future is one in which a healthy environment, economic prosperity and social justice are pursued simultaneously to ensure the well-being and quality of life of present and future generations. Education is crucial to attaining that future."[17] Relevance and importance of education cannot be undermined. As mentioned in the UNESCO Science Report 3[18] "*Towards 2030,*