
DEVELOPING TOOLS TO DESCRIBE GREEN MANUFACTURING PRACTICES

Prof. K. Rama Mohana Rao, M. Com, M.B.A., PhD, & Professor, Department of Commerce & Management Studies, Andhra University, Visakhapatnam, India,

Geleta Merera Bogale, Assistant Professor at Mettu University, Ethiopia, & Research Scholar in the Department of Commerce & Management Studies, Andhra University, Visakhapatnam, India.

Abstract

GM is a new and important agenda of the world emerging as solution for sustainability related problems of manufacturing industries. Despite, its urgency to be practiced, the issue is even not has been understood by the world communities and researchers in consistent and similar fashion. Hence, there are even no sufficient reviewed literatures concerning theories related to GM practices and no standardized tool to describe practices. To this effect, this paper has developed tools used for GM description and made simple revision of related literature. Accordingly, the specific objectives of the review were: 1 To develop comprehensive tool that helps to assess GM practices, 2. To review major theories related to GM practices, 3. To identify future research areas concerning GM for developing countries like Ethiopia. To attain these objectives simple review method and contextualization of the concepts to the practical environment of the manufacturing industry, especially of the Ethiopian context were employed. Accordingly, to test the validity of the GM practices assessment tools developed by the reviewer; two experts of the area were consulted to check the authenticity and appropriateness of the content. Whereas its reliability was tested using cronbatch alpha by feeding data collected from one of the cement manufacturing industry in Ethiopia using 63 respondents. Accordingly, major theories relate to GM were reviewed, comprehensive tools used to measure GM practices were developed, and future research areas were recommended. Thus, the following were the advises forwarded for future researchers to: assess GM practices in pollutant manufacturing industries including their policy practices, identify pollutant industries and barriers hindering the GM practices in developing countries, especially identifying the critical ones is very important, and to substantiate why GM is important by identifying the drivers for GM, especially identifying the major ones are highly recommended.

Key words: GM practices, and GM measuring tools

1. Introduction

GM is a new and important agenda of the world emerging as solution for sustainability related problems of manufacturing industries. Despite, its urgency to be practiced, the issue is even not has been understood by the world communities and researchers in consistent and similar fashion. Hence, there are even no sufficient reviewed literatures concerning theories related to GM practices.

There is a consensus that Green Manufacturing practices should be the main assignment of the manufacturing industries to be improved for the brightness of the world's future quality of life on this earth. With the explosion in world population and the increasing rate of consumption, it will be increasingly difficult to sustain the quality of life on earth if serious efforts are not made now to conserve and effectively use the earth's limited resources through practicing sustainable manufacturing strategy (Madu, 2001).

Based on the above conception any lay man can recommend the researchers of the area to undertake study on GM practices of the industries though, there is no standardized tool developed to survey the practices. Regarding this idea the absence of contextual comprehensive tools used for assessment of GM practices for developing countries like Ethiopia is more difficult. Moreover, it is dark that which area of the green concept to take as important and urgent areas to be studied is another puzzle of the researchers of these developing countries.

This paper aimed to tools to describe or assess GM practices. Accordingly, the specific objectives of the review were: 1 To develop comprehensive tool that helps to assess GM practices, 2. To review major theories related to GM practices, 3. To identify future research areas concerning GM for developing countries like Ethiopia.

2. Methods

To attain these objectives simple review method and contextualization of the concepts to the practical environment of the manufacturing industry context were employed. Accordingly, to test the validity of the GM practices assessment tools developed by the reviewer; two experts of the area were consulted to check the authenticity and appropriateness of the content. Whereas the reliability of it was tested using cronbatch alpha by feeding data collected from one of the manufacturing industry in Ethiopia using 63 respondents. As a result the cronbatch alpha score is 0.882 that assured the developed instrument was very good and said to be very reliable.

3. Major theories related to GM practices

3.1. Definition and short history

GM is defined by different authors in different ways. According to (Eibel, 2014) Green Manufacturing is the production of the similar goods at the similar quality level with less or no harm to the environment, including nature, people, and society. While (Digalwar, 2013) defined as manufacturing that has center of attention on environmental impact, environmental policies of governments, environmental regulations, stakeholder activism and environmentalism, and competitive pressures. And also, described as it was different from traditional manufacturing.

Ghinmine and *etal*, (2015) also defined GM as it is a system that amalgamates product and process design issues with a issues of manufacturing , planning and control in such a manner to identify , quantify , assess and manage the flow of environmental waste with the goal of reducing and ultimately reducing environmental impact while also trying to maximize the resource efficiency.

Although, Manufacturing has been a human activity for a very long time, as the progress is made in the manufacturing system the surrounding environment starts facing the problems of pollutions which leads to environmental degradations. This is because, Most manufacturing processes cause, to varying degrees, air, water and soil pollution – costs to society and the environment that need to be accounted, or internalized, and reduced (Gutowski., 2011).

The major challenge to the government was to protect the environment from these pollutions (Ghinmine., 2015). Hence, fresh air and clean water are becoming increasingly precious resources (CIF, 2002). The early 19thC manufacturing focuses mainly on mass production system than giving attention to green manufacturing and as progress is made to the manufacturing system the issue of environmental degradation became an agenda because of the pollutions made by manufacturing (Ghinmine., 2015). In general, the history of Green manufacturing agenda could be traced back to Brundtland report to the recent Copenhagen summit on which Africans visibly participated and Ethiopia also voiced her sound through her prime minister that the country has the aim of building green resilient economy supported by national policy of Ethiopian industry development.

3.2. Theoretical review

According to the different work summary of many authors compiled by (Henriques, 1999) concerning organizations theory approach to green issue; industries could be classified as; reactive, defensive, accommodative, and proactive. Whereas the GSCM literature which contains broad concept of GM by Sarkis *etal.*, 2010 recently categorized theory related with green agenda under nine organizational theory namely; complexity theory, ecological modernization, information theory, institutional theory, resource based view, resource dependency theory, social net work theory, stakeholder theory and transaction cost economics.

The theory of GM is grounded on four major theories, namely; institutional theory, resource based view, resource dependence and stakeholder theory (Bonface, 2013).

Different authors forwarded different categories of organizational theories applied to GM and related issues, and different future research directions. However the researcher tried to summarize and contextualize organizational theories of GM practices and future research directions based on the works of Sarkis *etal.*, 2010; Robin *etal.*, 2015 ; Hart, 1995; Bonface, 2013; Henriques, 1999. Accordingly, GM major theories could be categorized under four main theories, namely; institutional theory, resource based view, resource dependence and stakeholder theory. As a result, why and how firms adopt GM has commonalities, though different industries have variations due to heterogeneous pressures from various organizational groups. This explanation of similarity and differences may be derived from the theory they view as the reason for adopting GM.

Institutional theory: This theory basically examines how external pressures influence organizational actions (Sarkis, 2011) and (Bonface, 2013) pointed that the theory emphasizes the role of social and cultural pressures subjected to organizations that influence organizational practices. The summarized idea of different authors compiled by (Sarkis *etal.*, 2013) have forwarded that within institutional theory, three forms of isomorphic drivers exist namely, coercive, normative, and mimetic. As a result, an article by an above author suggested researchers to further diagnosis that may shade light on how internal and external factors promote Green practices.

Resource Based View: This theory takes the viewpoint that valuable, costly to copy firm resources and capabilities provide the key sources of sustainable competitive advantage. Concerning the comparative importance of internal firm capabilities versus environmental factors to sustained competitive advantage, facts suggest that both internal and external factors are vital to competitive success. But still this theory contains one serious exclusion: It systematically ignores the Constraints imposed by the biophysical (natural) environment. To the response of this

ignorance of natural resources the article by Hart (1995) filled the gap by proposing a natural resource based view of the firm-a theory of competitive advantage based upon the firm's relationship to the natural environment. It is composed of three interrelated strategies: pollution prevention, product stewardship, and sustainable development.

Resource Dependence view: Sarkis and *etal.*, (2011) confirmed that the theory of resource dependence view founded up on the idea which says, firms cannot be fully self-sufficient with regards to strategically critical resources for survival. This theory suggests the member firms in the supply chain should depend and collaborate to seek higher performance gains in the long run instead of pursuing short term benefits at the expense of others. As a result, Eco design of products and material recovery are unique organizational resources requiring firms' partnerships to effectuate performance benefits.

Stakeholder view: This theory suggests that companies produce externalities that affect stakeholders, which are both internal and external to the firm. Externalities often cause stakeholders to raise pressures on companies to reduce negative impacts and increase positive ones Sarkis *etal.*, 2010. Even though the influence of stakeholders have been different, stakeholders have been key influencers of green agenda (Robin., 2015)

4. Developing tools used to measure GM practices

To improve any practices, knowing the practice level of the issue should be the first step. Whereas the instrument used to measure whether the industries are successfully implementing GM or not, should be designed well in a way it could confirm the real practice level. Regarding this issue, Many Authors designed models and tools to Assess GM practices of the Manufacturing Industry. Among the authors (Rosen, 2012) Forwarded that today's, manufacturing strategies generally account for products and processes, as well as other parameters like practices, so as to incorporate organizational and philosophical elements of manufacturing strategy. Accordingly Environmental improvement practices related to manufacturing industry are; Products design to be environmentally benign processes (reduction, reuse, recycling and remanufacturing, Zero-emission) and ISO 1400 principle implementation.

According to (Digalwar, 2013) the performance of GM practices should be measured by; Top management commitment, Knowledge management, Employee training, Green product and process design, employee empowerment, environmental health and safety, Supplier and materials management, production planning and control, Quality, Cost, Social responsibility, and Corporate reputation.

The model formulated by (Bigliardi, 2012) says GM practices of the firms could be confirmed based on; *company's strategic priorities* (maximizing profit/minimizing costs; shareholders satisfaction; customer satisfaction; creation of new collections which meet the current trends; creation of environmental friendly collections and items; ensuring an adequate working load among employees; guaranteeing jobs to the employees; maintaining an adequate climate in the working environment; increasing company presence worldwide), *Eco-production, company's behavior towards stakeholders' requests* (Independent decision making, collaboration with stakeholders, and etc) and *Stake holders interest in the introduction of Environmentally friendly items* and the likes were tools used by above author to assess the GM practices of one of Italian manufacturing companies.

According to (Bhattacharya, 2011) the following framework help companies to assess whether they are successfully implemented green or not; *Plan* (Embed Green into the strategy and plan for rollout across the value chain, Define metrics for Green initiatives and set targets for success), *Execute* (Green Energy, Green Products, Green Processes) and *Communicate* (Create awareness about benefits of Green products, Publicize the Green orientation of the firm). In this context



green energy represent; Increase use of clean energy and Increase efficiency of energy use while green product represent; Incorporate Green into the product strategy, Design product for sustainability over the entire product lifecycle and green process mean; Incorporate Green across the entire value chain, Reduce wastages and increase recycling.

Also (A. Anton Arulrajah, 2015) added an insight that directs researchers to assess the human part of the organization to check whether organizations are practicing green or not. According to this study HRM has gigantic potential in greening organization and its operations. So that without proper green HRM practices, it is difficult to create and maintain sustainable environmental performance. This could be assessed by assessing whether functions of HRM are green or not.

To sum up, the models used above by different parts individually not fit enough to assess the practices of GM in manufacturing industry. So the researcher has prepared the model that encompasses every element comprehensively.

According to the newly developed tool, the composition of the items listed to measure GM practices starts from policy practices measurement elements. Hence, it is fact that policy is a broad guide line under which every development activities of the country or organization is governed. The overall policy framework of a country has an important influence on the greening of industries, as it provides the environment through which industrial changes can take place. The greening of industries is about strategic thinking that requires government or industry management with effective green industry policies, initiatives and implementation (UNIDO, 2011).

Regarding policy related measurement tools, different works of authors like; UNIDO, 2011; Bhattacharya, 2011; McKinsey Global Institute, 2012; OECD, 2012 were reviewed. Accordingly, all of them have consensus that effective policy will help in improving the GM practices, though there is no universally accepted measures of policies and their implementation. So a policy measure that fits to every countries direction is yet demanded. As a result the researcher designed contextual tools that are expected to measure policy practices of GM in every country manufacturing industries using these authors work as an input.

The following tools are designed by the researcher to assess the practices of GM.

A. Policy related GM practices measuring tools

1. Country level policy practices measuring tool

Government policy and practices on green manufacturing	
1.	Government sharpened policy measures that promote Manufacturing industries to investment in green manufacturing
2.	Government Established and widely promoting a framework to recognize green products through 'Green' ratings of manufacturing.
3	Policy is strengthened and incentives are coordinated from multiple agencies to promote efficiency measures during manufacturing for green practices
4	Government ensured greater coordination across institutions promoting sustainability and green manufacturing to hold manufacturing industries accountable..

Opinion on Government initiatives of Green manufacturing

Emission and discharge standards

1. Government has prescribed emission and discharged standards for manufacturing industries to reduce pollution
2. Government provided continuous incentives ,including monetary to encourage environmentally friendly manufacturing
3. Government encourages reduction in releases of harmful pollutants and to ensure that the standard are compiled with

Green manufacturing committee

1. Government planned and devised a system for defining and implementing greener and cleaner technologies to solve problems related with loss of green manufacturing
2. Objective criteria were prescribed by green manufacturing committee comprising representatives from the concerned ministries/departments and relevant sectoral experts to measure the successfulness of green manufacturing agendas

Technology acquisition and development fund

1. Technology acquisition costs are reimbursed by government if industries could manufacture equipments used for controlling pollution and reducing energy consumption to improve green manufacturing
2. Government provided interest reimbursement of the interest charged by lending agencies in addition to a capital subsidy for the industry units investing their resources on greening of their operation to encourage the continuity of greening.
3. The fund raised for greening of the industry is functioning as an autonomous patent pool and licensing agency. As a result it purchases intellectual property rights to inventions from patent holders and provides the same to companies against the payment of royalties

2. Industry level policy practices measuring tool

Green manufacturing future plans of your industry(FP)

1. Planned to build financial support structures to support the greening of manufacturing activities in the industry (e.g. like green trust fund)
2. Planning to have high quality links with national and international demand to stimulate environmental technologies amongst manufacturing units.
3. Plans to remove environmentally harmful subsidies
4. The industry plans recognize sound environmental management as a competitive advantage
5. The industry does plan for harnessing the benefit of globalization through green corporate image and reputation
6. Plans to invest in resource efficient infrastructures
7. Plans in supporting local societies and local authorities
8. Plans to develop the skill base of workers, management bodies and society in general of green manufacturing activity programs

Surveillance and control mechanism(SC)

I	Industry standards(SCI)
1	The industry established environmental management system
2	This industry performs continuous environmental auditing
3	Environmental performance evaluation is practiced in this industry
II	Product related (SCP)
1.	There is environmental labeling
2	The industry undertakes life cycle analysis
3	The industry sets environmental aspects of product standard

Campaigns undertaken to realize GM practices, and GM enrichment mechanisms are also included under industry level policy practices assessment tool components.

B. Operational GM practices measuring tools

Item No	Statements
I	Green Process Design Practices Perspectives
1	Process is designed for optimum energy consumption of material/energy
2	Process designed including reuse, recycle and recovery of material and/ or component parts
3	By Process design the industry is avoiding or reducing use of hazardous substances
4	Through Process design the industry reduces wastage (solid, liquid and gas)
5	Using Process design mechanism the firm meets environmental and safety standards
6	Process is designed for minimal usage of natural resources
7	Co-operation & feedback sought from customers in developing eco-process design
II	Process focus dimensions
1	Products have the possibility of being recycled, reused.
2	Manufacturing activities ensure less usage of hazardous materials in the process.
3	Product life cycle approach is used to improve the environmental performance and production efficiency of the product
4	Measures were taken to reduce material, water and energy used in manufacturing
5	Waste management program for compliance with all applicable regulations
6	Optimizes the use of energy generated from renewable resources in manufacturing operations
7	Minimizing toxic waste during manufacturing
8	Selection and use of energy efficient equipments and fixtures
9	Development of prevention program to identify and eliminate sources of pollution
III	Leadership or internal environmental management system practices
A	General Management system aspect
1	Senior management commitment to GM
2	Support for GM from junior and middle level managers/executives
3	Cross functional co-operation for environmental improvements
4	Induce Total quality environmental Management
5	Promotion of quality circles
6	Provision of training in environmental management

7	Awareness of GM practices adopted by competitors
8	Environmental performance measurement and monitoring
9	Updating the current and proposed environmental regulations and legislations that may impact the firm
10	Existence of environmental auditing program
B	Greening of HR perspectives
	Recruitment
1	Green job descriptions for employees (and green goals included into managerial job descriptions)
2	Graduate perceptions of Green practices (applicants use green criteria)
3	Recruitment of employees who are 'Green aware' becomes part of the interview schedule
4	Green aspects introduced to the induction process (familiarization)
	Performance Management & Appraisal
1	Green performance indicators into performance management system, and appraisals (PMA)
2	Communication of Green schemes to all levels of staff through PMA scheme, establishing firm-wide dialogue on green matters
3	Managers are set green targets, goals and responsibilities
4	Appraisals assess number of green incidents, use of environment responsibly, & successful communication of environmental policy
5	Penalties for noncompliance on targets in environmental management (EM)
	Training & Development
1	Introduce training on EM, & processes/material use
2	Integrating training on instruction and generation of eco-values
3	Development of employee skills, and competence building in EM
	Employment relation
1	Employee involvement & participation in Green suggestion schemes, & problem-solving circles
2	Staff independence to form & experiment with green ideas
3	Set-up low carbon chiefs (including CEO and Board) to increase action in EM
	Pay and reward
1	Green pay/reward system
2	Tailor packages to reward green skills acquisition
	Exit
1	Staff de-briefings in EM in cases of dismissal
2	Managers to ask if Green issues are reasons for resignations (moving to a greener employer?)
IV	Occupational safety and health hazards perspective
1	Written safety rules and regulations
2	Management commitment to workers safety
3	Employee safety committees
4	Safety hazard assessment
5	Safety and health training
6	Improvements in worker safety
7	Motivate workers for environmental consciousness
8	Increase supervision training
9	Accident reporting and investigation
10	Promoting safety and health activities

5. Identify future research direction concerning GM

Manufacturing sector is growing worldwide at a very fast pace in order to meet the demand of the goods required. The countries, particularly developing countries are working hard to have a high growth in manufacturing sector to boost their economy. However, the challenge of sustaining high growth of the manufacturing sector without harming the environment becomes the headache among industries, academia, governments, and international communities.

It is observed that all studies, tried to discuss some issues about green manufacturing and emergence of green philosophy, but still there is gap on determining to what extent the manufacturing industries practiced green manufacturing.

To have full understanding of GM practices, it is obvious that why we implement GM, and what barriers hinder the implementation should be clear. This implies that the knowledge of drivers for and barriers to GM are important to fully describe the practices of GM in manufacturing industries. Hence, having knowledge of drivers is important factor for industries since drivers justifies the reason for investing in GM (Mittal, 2007). Whereas proper understanding of barriers is necessary hence, the presence of these various barriers makes the implementation of green issue complex to the industries (Govindan., 2014).

6. Recommendations

Based on above research gaps: for future researchers especially for those who want to undertake study in the area of GM especially of the developing countries, it is advisable:

- ✚ To assess GM practices in pollutant manufacturing industries including their policy practices
- ✚ To identify pollutant industries and barriers hindering the GM practices in developing countries, especially identifying the critical ones is very important.
- ✚ To substantiate why GM is important by identifying the drivers for GM, especially identifying the major ones are highly recommended.

7. REFERENCES

- Anton Arulrajah., E. (2015). Green human resource practices:a review. *Sri Lankan Journal of Human Resource Management* , Vol.5, No.1,.
- Bhattacharya, A. (2011). *Green manufacturing*. India: Boston consulting group.
- Bigliardi, E. B. (2012). Green manufacturing practices in the fashion supply chain: lessons from Italian case studies. *Int. J. Agile Systems and Management*, Vol. 5, No. 1 , 4-28.
- Bonface. (2013). Adoption of Green manufacturing practices by food processing firms in Mombasa county. *University of Nairobi* , 1-64.
- CIF. (2002). *Cement Industry Environment Report*. Brighton: Cement Industry Federation.
- Digalwar, E. (2013). Green Manufacturing performance measures: an emprical invastigation from Indian Manufacturing Industries. *Measuring Business Excellence,Birla Institute of technology and science* , 59-75.
- Eibel, D. (2014). An essential success factor in globalized world. In A. M. foundation, *Green Manufacturing* (p. 3). syria-Austria: Syria university of Applied science.



- Gutowski., E. (2011). Investing in energy and resource efficiency. In e. Robert Ayres., *Manufacturing* (pp. 242-285). Beijing, sao polo etc: UNEP.
- Ghinmine., E. (2015). Implimentation of green manufacturing in industry;case study. *International Journal of Research in Engineering and Technology* , 2321-7308.
- Hart. (1995). A natural Resource Based View of the Firm. *Academy of Management Review Vol. 20. No.4. , 986-1014.*
- Henriques. (1999). Relationship between environmental commitment & Managerial perceptions of Stakeholder importance. *The Acedamy of management journal* , 87-99.
- Madu, C. (2001). *Environmentally concious Manufacturing*. New York: Springer Science+Business Media.
- McKinsey Global Institute. (2012). Manufacturing the future:The next era of global growth and innovation.
- Mittal, V. K. (2013). *Development and Validation of Drivers for, Barriers to and Stakeholders of Green Manufacturing (unpublished doctoral dessertation)*. Pilani.
- Steve Bass, Shannon Wang, Tadele Ferede and Daniel Fikreyesus (2013), “Making Growth Green and Inclusive: The Case of Ethiopia”, *OECD Green Growth Papers*, 2013-07, OECD Publishing, Paris. doi: 10.1787/5k46dbzhrkhl-en
- Robin., E. (2015). Effects of Green Innovation on Environmental and Corporate Performance: A Stakeholder Perspective. *www.mdpi.com/journal/sustainability* , 4997-5026.
- Rosen, H. A. (2012). Sustainable Manufacturing and Design:Concepts, Practices and Needs. *Sustainability* , 154-174.
- Sarkis, E (2010). An organizational theoretic review of Green supply chain Management. *IternationalL Journall Of Production Economics*
- Sarkis, E (2011). An organizational theoretic review of Green supply chain Management. *IternationalL Journall Of Production Economics*
- Sarkis, E (2013). An organizational theoretic review of Green supply chain Management. *IternationalL Journall Of Production Economics*
- Steve Bass, Shannon Wang, Tadele Ferede and Daniel Fikreyesus (2013), “Making Growth Green and Inclusive: The Case of Ethiopia”, *OECD Green Growth Papers*, 2013-07, OECD Publishing, Paris. doi: 10.1787/5k46dbzhrkhl-en
- UNIDO. (2011). *UNIDO Green Industry*. Vienna: Vienna International Centre.