Quality Green, EMS and lean synergies: sustainable manufacturing within SMEs as a case point

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Abstract

The aim of this paper is to examine the synergies between lean, EMS and green systems, manufacturing management strategies as found in the literature, with a focus on the co-occurent implementation of these strategic initiatives, in order to develop a research agenda to guide a theoretically based future research to assist small-medium enterprise (SME) managerial decision making. An in-depth literature search unveiled drivers and conflicting points across the manufacturing strategies. Separate literature inundations have risen to address implementation issues in EMS, lean, green for manufacturing sustainability, but the relationships and possible intersections of these three has been neglected. The current research unifies the literature addressing the synergies, divergences and suggests a research agenda to address the gaps in the literature. Additionally, recommendations are provided for SMEs as well as policy makers to consider for a successful implementation of sustainability goals.

Keywords: *SME ; manufacturing; system synergies*

1. Introduction

Today's SMEs (Small-to-Medium sized Enterprises) need to address the increasing global competition, decreasing product life cycles and increasing customer demands. [1] Sustainability in manufacturing SMEs is important to achieve increased market share while reducing environmental risks and impacts while improving the environmental efficiency of manufacturing SMEs which require more financial and technical assistance when compared to OEMs (Original Equipment Manufacturers) when moving from reactive measures for the end use of products to a more proactive consideration within part design and plant operation. EMS (Environmental Management Systems) are strategic management approaches that define how a manufacturing company will address the impacts on the natural environment. While prior research has evaluated the underlying reasons why companies adopt EMS and the potential these environmental strategies have for improving the environment, the issue remains that EMSs do not require the companies to improve their environmental performance but instead focus on creating and documenting environmental procedures and policies. [2][3] Moreover, there isn't a way of verifying using an external agency, whether a company's environmental performance improvements actually occur. [4] Hence, EMSs may represent only symbolic efforts to improve an SMEs image. [5] Despite these concerns, the operational capabilities necessary to adopt an EMS may help a company's efforts to reduce its environmental impacts. [6] EMS adopters therefore maybe more likely to rely on their complementary knowledge-based capabilities of lean while working on reducing their system-wide environmental impacts.

The lean strategy based on waste management and flexibility embraces all the processes through a products life cycle. However, when manufacturing companies are subject to external conditions such as green environment or political crisis, the lean practices may have aided the decline of energy efficient conditions. [7] *Green* is used as a term for exploitation of energy and resource efficient production. From a descriptive standpoint, green measures and methods are added to standardized lean methods, mainly executed by applying a list of measures for energy efficiency. [8]

The tradeoffs between lean, EMS and green management paradigms may help manufacturing SMEs to become more efficient and sustainable. The paper analyzes the potential of EMS for advancing environmental sustainability for SMEs. It characterizes the relationship between EMS and green indicating whether EMS complement green strategies. This paper presents a conceptual model for manufacturing SMEs which can be the basis for future research addressing the three paradigms contributing to their sustainability issues.

2. Paradigms Review

2.1 Environmental Management Systems (EMSs)

An Environmental Management System consists of policies, assessments and implementation action plans affecting a manufacturing organization and its relationships with the environment. [9] Irrespective of variety of manufacturing processes and organizational features, all EMSs involve putting in place an environmental plan; performing internal assessments of

organizational environmental impacts; forming quantifiable goals to decrease environmental impacts and providing resources; checking implementation progress through auditing; identifying and implementing corrective actions in case of deviations from the goal and undergoing management review. [9] Based on the continuous improvement model by Deming; EMSs help organizations incorporate environmental practices within their manufacturing frameworks and hence making environmental protection an integral element of the company's business strategy. [10] For the reasons described, EMS is increasingly being recognized as a comprehensive mechanism to improve environmental performance. [11]

Once the EMS is in place, a manufacturing enterprise can elect to be certified to ISO 14001 standard which requires certification by an independent third party auditor, who ensures that the EMS conforms to the ISP 14001 standard. [2][3] Manufacturing enterprises that adopt EMSs, can benefit from improving their regulatory compliance, enhancing their image and competitiveness. Interest in EMSs extends beyond the organizations that adopt them. Policy regulators are especially interested in their potential to achieve greater environmental protection. [9] [11] While EMSs have been linked to stronger environmental performance than other environmental techniques, such as, corporate environmental reporting this improved performance may not occur at all. [12][13] because some manufacturing enterprises may be adopting EMSs superficially in an effort to improve their reputation without reducing environmental impact, since there is no way for third parties and external stakeholders to verify whether environmental performance improvements actually occur. [4] However, EMSs may encourage some manufacturing enterprises to expand their environmental considerations beyond their operations, to their customers.

2.2 Green Systems Technology Integration

Environmentally sustainable green systems have emerged to help companies improve manufacturing competitiveness by reducing environmental risks and impacts and improving their efficiency. [Zhu 2008][Rao and Holt 2005] Changing government policies make industry responsible for post-consumer disposal of manufactured products, forcing both manufacturers and researchers to implement sustainable practices across the supply chain. On the other hand, increasing pressures from community and environmentally conscious consumers force the manufacturing companies to effectively integrate environmental concerns into their manufacturing management practices. [14]
The importance of having an understanding of the capabilities and goals considering technological integration for systems aspects in manufacturing processes cannot be overstated. For instance, this high level integration can help to decrease uncertainty and risk related to environmentally energy intensive processes or environmentally related product innovations. [16][17] By reducing uncertainty and cooperating on strategic level processes that form a part of the green technological innovation, the pressure to investigate specific outcomes decreases. [18] However, this is not the only possibility. Technological integration with strategic knowledge flowing between manufacturing enterprises can be viewed as an asset investment. [19] Long term technological integration might, at some point in the future, encourage opportunistic behavior, possibly through intellectual property issues. Hence, additional monitoring is essential to ensure mutually beneficial outcomes.

2.2.1 Foundry SMEs Case Point

Over the course of last twenty years, a team has been working on innovative sustainable technologies for the metalcasting SME industry, with a focus on cast iron foundries. [16]The innovative technologies help save costs by reducing clay, coal and sand use, while reducing air pollution from volatile organic compounds (VOCs). This helps reduce VOC pollution by one-third. Other technological innovations involve applying advanced oxidants and hydroacoustic activation to spent greensand in a manner that restores the binding activity of sand. The advanced oxidation process has been made commercially available and installed in sixty foundry linings. The major upstream activities –power production, coke making, and sand mining –provide inputs of electricity, coke, and sand respectively, requiring fuels and raw materials and generating emissions.

Cupola melting and other foundry activities require melting inputs, such as ferrous metal alloys, scrap metal and natural gas. They also require process inputs, such as parts and supplies. The entire process chain-from primary fuels and materials production through the manufacturing plant gate-produces finished case iron products and potential environmental discharges. Most significant cost, energy and material savings would occur when foundries adopt a combination of innovative technologies, such as, coke replacement with anthracite bricks, advanced oxidation-hydroacoustic cavitation for green sand reclamation and use of collagen-alkali silicate binders. If the coke replacement technologies that are being considered for sand casting were also adopted in the steel industry, the ramifications would be profound. This could significantly reduce emissions and reliance on dwindling world supplies of metallurgical grade coal. [22]

1.1. Lean and Green

Ohno [20] developed the lean management approach at Toyota Motor Corporation in Japan, that provided the two main pillars of *automation* and *just-in-time*, forming the basis of the Toyota production system. The focus of the lean management approach has been on the reduction of waste to eliminate non-value adding time to meet the ever changing customer demand. Richard and Holweg [21] extended the lean concept downstream, beyond the manufacturing plant boundaries, helping customer receive the right product at the right time and place. Within the manufacturing facility operational level the lean paradigm is implemented using a number of techniques such as *Kanban*, 5S, visual control, takt-time, poke-yoke and single-minute-exchange-of-dies. [22]

Table 1 shows relevant and seminal references over a two decade evolutionary timeline with that maybe used as a broad frame-of-reference to develop models and concepts that help managers and other stakeholders integrating lean and green choices to guide future research. The inherent complexity of lean and green sustainability issues such as – multiple stakeholders, increasing globalization and competitiveness and international importance- presents significant challenges to the research community. Much effort is required to support the evolution in manufacturing sustainability practice towards greening the industry on a global level.

Year	Lean	Green
1990-1994	Roy and Whelan (1992) [23]; Caruso et al. (1993) [24]	Gupta and Taleb (1994) [35]; Crainic et al. (1993) [36]
1995-2000	Hanna and Newmann (1995) [25]; Richter (1996); Bloemhof-Ruwaard (1996) [26]; Richter and Dobos (1999) [27]; Bellman and Kahre (1999) [28]	Johnson and Wang (1995)[37]; deRon and Penev (1995) [38]; Guide and Srivastava (1998) [39]; Krikke et al. (1998) [40]; Richter (1996) [53]; Van der laan and Salomon (1997) [41]; Guide et al. (1997 a,b,c) [42][43][44]; Ferrer (1997 a,b) [45][46]; Bras and McIntosh (1999) [47]
2000-2004	Sarkis and Cordeiro (2001) [29]; Teunter and Vlachos (2002) [30]; Hicks et al. (2004) [31]	Inderfurth et al (2001) [48]; Richter and Weber (2001) [49];Savaskan et al. (2004) [50];
2005- …	Nagurney and Toyasaki (2005) [32]; Woolridge et al. (2005) [33]; Masui (2005) [34] …	Fleishmann et al. (2004) [51]; Guide et al. (2005) [52] …

Table 1. Evolutionary timeline

1.2. Relationship between EMS adoption and Green: Capabilities and External Pressure

The relationship between EMSs and green practices, both within and beyond the company's internal boundaries, has potential synergies and significant results for a company's environmental sustainability, because they together offer comprehensive way to establish sustainability among manufacturing enterprises. Institutional pressures persuade manufacturing companies to encourage adoption of these complementary practices to increase external legitimization. [54][55] Regulatory pressures are often associated with a company's decision to adopt an EMS and utilize green practices [56]. These pressures arise from threats of non-compliance, penalties, and requirements for public disclosure about toxic chemical releases. [57] [58] Moreover, pressures from regulators may encourage companies to adopt proactive environmental practices and start collaborative projects to foster environmental improvements. In adopting EMS and green practices, manufacturing companies maybe able to communicate more effectively to government that they are committed to improving their environmental performance.

Manufacturing companies are subject to pressures from communities that include environmental groups, community groups, labor unions and industrial consortiums. [59] Each of the stated groups can gather public support for or against a company's environmental performance. EMS and green practices adoption may be one way for companies to indicate to the community and regulatory stakeholders that their environmental management practices are sound. EMS and green practices maybe synergistic because manufacturing companies that adopt them possess competencies to endure institutional and stakeholder pressures.

2. Paradigms Characterization

Table 2 shows an overview synergies and discords between the lean and green eco-initiatives. The impact of each initiative implementation may be different. The lean initiative seeks the 'reduction of production and transportation lead times' and other forms of wastes and non-value adding activities. Attributes such as 'inventory levels', when present in-excess to the requirements, could be considered in conjunction with lean and green initiatives. It is essential for EHS (Environment Health and Safety) personnel at the manufacturing enterprises to participate in planning for and conducting Lean events on plant-wide manufacturing processes because of the potential risks of non-compliance and the potential hazards to workers. EHS staff can also bring fresh ideas and new tools to add to the solution set during activities such as 'value stream mapping'.

Example Attributes	Lean	Green
Attentiveness to material and energy use during value stream mapping	-	+
Recording process waste while conducting value-stream mapping	-	+
Frequency of plantwide Information	+	O
Identifying energy intensive processes during plantwide Kaizen events	-	+
Seeking to reduce Inventory Level	-	-
Seeking to reduce Production and Transportation lead time	-	-

Table. 2. Synergies Table ('+'synergy/ synergistically increase, '-' divergence, 'o' no consequence)

4. Summary and Policy Implications: Encourage action by industry

Several research avenues regarding the outcome of lean, green and EMS practices can be developed for manufacturing enterprises. First, it would be interesting to see the impact of green on the selection of different environmental technologies. For example, does the sustainability collaboration between manufacturing enterprises lead to the selection of more product or process based changes with regards to the environment. Another avenue would be the study of influence of green on manufacturing process performance eg. impact on flexibility.

Manufacturing industry's response to pollution and resource degradation should not be limited to compliance with regulations. A broad sense of social responsibility and

awareness of environmental considerations at all levels should be ensured. Towards this end, manufacturing enterprises, trade associations and labor unions could work together to establish company-wide or industry-wide policies concerning resource and environmental management and compliance with international laws in the countries that they operate in.

With limited resources at their disposal, small and medium-sized enterprises often find themselves unable to afford the changes necessary to meet environmental regulations and product controls. Small scale operations such as metalworking, casting, machine tools etc. are frequently among the worst offenders of environmental regulations across countries. Energy saving biological systems may be well suited to the requirements of SMEs for pollution control or waste disposal.

SMEs constitute the largest segment of industry in most nations, and may in some cases need financial and technical assistance from the public sector. Management and labor training can help SMEs incorporate cleaner technologies and environmental planning to their in-house production systems. Additionally, governments need to encourage collaborative efforts which bring together smaller firms in joint research and development on environmental issues, for example, combined use of waste treatment facilities.

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