

Sustainable Manufacturing: Integrating Lean and Green

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Abstract - The adoption of lean and green operational practices and independently the uptake of business practices related to sustainability and corporate social responsibility continues to grow. Past research has hinted at relationships between these two areas – suggesting that “lean is green”. The lean mantra of waste reduction and “doing more with less” is immediately apparent as delivering environmental benefits and has formed the basis of past research. Almost all research linking lean and green operations to sustainability issues have focused exclusively on environmental impact. The purpose of this paper is to explore the broader sustainability benefits of lean and green operations

Keywords:- Lean Manufacturing , Green Manufacturing , Sustainability , Environment

I. INTRODUCTION

The Brundtland report titled “Our Common Future” released in 1987 by United Nations World Commission on Environment and Development (WCED) defines sustainable development as “development that meets the needs of the present without compromising the

ability of future generations to meet their own needs.”

Sustainability in manufacturing has achieved special attention from many researchers and several research papers have been published in this new realm of science . However, sustainability is a widely accepted idea with little guidance about its practical implementation and impact towards firm’s performance. Manufacturing industries account for a significant

part of the world's resources consumption and waste generation. Nevertheless, they have the potential to become the driving force for creating a sustainable society. They can design and implement integrated sustainable practices and develop products and services that contribute to better environmental performance.

The long term sustainability of the corporation largely relies on how organizations maintain their competitiveness, while simultaneously preserving a sustainable environment. In recent years, many organizations have implemented environmental sustainability programs in their organizations; however, it is difficult to find details on their implementation. In cases which the details are available, the focus tends to be on the specific technology rather than a broader industrial engineering perspective. In addition, current sustainable manufacturing practices are not well mapped. Therefore, the justification and mechanism for improvements and their impacts are unclear. (M. Despeisse, 2012.)

II. Sustainable Manufacturing Challenges

Manufacturing industries are confronted with a new major challenge on sustainability due to depleted energy and natural resources, devastating global environment deterioration, and human desiring in higher life quality. Generally, the challenge for companies in both manufacturing and services is to design products, services and delivery processes that will leave

less carbon footprint, and simultaneously, stay²³⁵ competitive in the global market. One of the key challenges for companies to practice sustainable environmental development programs (i.e. green practices), is an unsupportive organization culture which lacks institutional incentives. Other challenges faced by global organizations to practice a holistic and integrated environmental program include price competition among suppliers and the high cost of practicing sustainable manufacturing

III. Green Manufacturing

Green manufacturing (GM) is defined in most generic manner as “manufacturing practices that do not harm the environment during any of its journey phases” It involves green design of products, use of environmental friendly raw materials, eco-friendly packing, distribution, and reuse after end of life of product. It slows the depletion of natural resources and lowers the trash. Its emphasis is on reducing parts, rationalising materials, reusing components. It covers a number of manufacturing issues, including 6Rs i.e. reduce, reuse, recycle, recover, redesign and remanufacturing conservation, waste management, environmental protection, regulatory compliance, pollution control, and other allied requirements. There are ample opportunities for improving organisational efficiency through GM practices, influencing financial gains along with environment protection. Balancing environmental and

economic performance has become significant for organisations facing regulatory, competitive and community pressures. Many countries have started campaigns to promote GM, and are emphasising on use of recycled material with reduced energy consumption. (R.L. Shrivastava)

IV. Green manufacturing practices: India and developing countries scenario

Green related developments evolved hand in hand with manufacturing management practices. Prior studies reported that environmental issues would be critical for manufacturing firms in Asia over the next few decades (Diabat and Govindan, 2011; Zhu et al., 2005). Teles et al. (2015) identified reduced consumption of natural resources and waste treatment as the environmental practices are popular, among the best performing GM practising Brazilian companies. In China too, the environmental issues have become more prominent (Zhu et al., 2005). Similarly, empirically examined the communication capabilities for GSCM and relationship among green integration, green cost reduction, and corporate competitiveness from the suppliers' perspective in Korean context. Strict policies and regulations in developed nations (U.S, EU) resulted in effective GM system implementation. But in developing scenarios, GM is still in its infancy. Study on GM in India by (Rehman and Shrivastava, 2013) revealed that the majority of Indian companies don't have enough awareness on GM and there

are many gaps and confusions regarding GM²³⁶ implementation their study also confirmed that more effort will be needed to establish GM concepts. Seth et al. (2008) addressed various wastes in the supply chain of the edible oil industry and stressed the need for lean with green. Due to relatively less empirical research studies about GM in developing country contexts, many managers perceive it as obstacle rather than a potential opportunity to improve. Indian firm's sustainability strategy influences the design and deployment of GSCM strategies. Indian petrochemical industry has ample scope for improvement of organisational efficiency through green innovation approach that envisage use of eco-friendly process and product, reduced resources and waste. Researchers have examined impacts of CSFs of GSCM in Indian automobile industry and identified regulation, internal management and competitiveness as critical factors. GM companies has a positive effect on both financial and environmental performances. The impact of green initiatives also varies by the industry and sector. Green initiatives in power sector have the maximum impact on reducing CO2 emissions as compared to others. To comply stringent environmental controls and to achieve financial gains by improving performance, Indian companies will have to follow GM practices and demonstrate commitment to green philosophy. Indian companies are moving towards GM, as many of their counterparts are structuring environmental sustainability into their business

practices. For example, Wal-Mart,(Shrivastava 2016)

V. Lean Manufacturing

The global industry in 21st century has forced most of the leaders in several sectors to implement more competitive manufacturing system. The best answer as found in the journals is lean manufacturing. Initially it's started at Toyota plant, Japan ,which is known Toyota Production System (TPS). It has been widely known and implemented since 1960.

Lean manufacturing will be the standard manufacturing mode of the 21st century. There is no alternative to lean manufacturing. Researchers agreed that lean manufacturing could be a cost reduction mechanism and if well implemented it will be a guideline to be world class organization. Theoretically, Lean Manufacturing can be applied to all industries. Lean manufacturing was successfully implemented in the tableware industry. Therefore, SMEs have been encouraged to apply it. It is now widely recognized that organizations that have mastered lean manufacturing methods have substantial cost and quality advantages over those who still practicing traditional mass production. Lean manufacturing combines the best features of both mass production and craft production, the ability to reduce costs per unit and dramatically improve quality while at the same time providing an ever wider range of products

and more challenging work. The goal of lean²³⁷ manufacturing is to reduce the waste in human effort, inventory, time to market and manufacturing space to become highly responsive to customer demand while producing world-class quality products in the most efficient and economical manner.

VI. Intergrating Lean and Green

Lean and green operations. Early research suggested that a win-win scenario existed with environmental and economic performance. Subsequent studies have sought to investigate in more detail the reason for this is that environmental and industrial/economic performance improvement are interlinked as both stem from a common drive: "Firms that are innovative in terms of their manufacturing process are likely to be more imaginative in addressing environmental costs and risks"

Just one example of this is in new product development; one important outcome of innovation and/or lean operations is increased new product development. With new generation of products, the firm has the opportunity to redesign layout, facilities, engage new suppliers, work with new materials, and address closed loop issues at the design stage. The generational shift provides a greater opportunity for environmental improvement than retro-fitting environmental issues to existing products or processes. Another area of mutual development concerns international standards.

VII. Addressing full sustainability

A range of drivers have been identified for improvement in OM sustainability in practice: for instance classifies internal drivers (cost reduction by waste reduction) and external drivers (government or customer pressure to improve sustainability performance). However, what “sustainability” actually means is far less certain. While definitions of “sustainability” are often limited to environmental concerns, a full range of issues have been identified as relevant beyond the natural environment.

(i) **The environment issues**

Related to the impact on the natural environment of business operations, including: pollution and emissions from production and the materials used in products, energy use, emissions from transportation, use of recycled materials in production, and recycling of products post-consumption. A range of environmental benefits from lean production have already been identified. The core premise is that producing the same output with less resources (materials, energy, capital) is inherently good for the environment while also reducing the cost of operation for the company. Similarly, by improving quality (a core lean objective) there are less production defects and resultant scrap/rework, further reducing cost and environmental impact.

(ii) **Workforce issues**

Related to how an organisation treats its staff. Four sub-dimensions were identified: workplace operational issues (providing a safe working environment with good working conditions), compensation (fair wages and payment), diversity issues (non-discrimination in hiring) and union relations (recognition). Research has previously identified a positive correlation between worker engagement/involvement and environmental performance. Improved working conditions are a mutual aim of lean operations and sustainability.

(iii) **Supply chain issues**

Concerned how an organisation monitored and responded to the behaviour of third-party organisations beyond their ownership. This included labour practices (human rights recognition such as avoiding sweatshops or forced/child labour), treatment of suppliers by the organisation (such as paying on time and open and honest dealings) and fair trade/ethical sourcing issues (positive behaviour to support suppliers). Lean supply chain strategy focuses on building close, long term relationships with high levels of information transparency with suppliers for the purposes of cost reduction and quality improvement.

(iv) **Community contributions**

This related to the positive impact of the organisation in the community in which they operated, for instance, through charitable donation and positively supporting the community. Maintaining a positive reputation in

the local community is an explicit part of the strategy setting process within the lean organisation. This issue, while often overlooked, has been key to a range of lean organisations. For instance at Toyota, since the 1950s, there has existed a clear focus on community issues focused directly on operating communities of current and former sites and employees.

(v) Governance and ethics

This concerned issues related to the management of corporate activities, including: socially responsible investment, public disclosure of activities, having a clear and written ethics policy, and ensuring legal compliance. Transparency of information within the firm and across firm boundaries underpins these sustainability issues. The shift toward this transparency is also fundamental in any lean organisation. Standardised work routines, and clear communication channels to employees, suppliers, and customers, are all elements of a lean operation.

Conclusion

This paper reports on a multi-case investigation of how lean and green operations demonstrate significant sustainability benefits. From this study we also highlight how sustainability practices support a range of lean transformation goals. Where previous studies of lean and green operations have limited their investigation to a study of environmental benefits at the workplace level, this paper identified strategic, supply chain and workplace activities

that implemented for lean and green improvement²³⁹ offer sustainability improvement either explicitly or implicitly. The conceptual foundation of the paper outlined that a range of potential benefits may accrue from integrating lean and green implementation. Further, the process of integrating lean and green to sustainable change was integrated into a theoretical model to capture the holistic change process

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