THE INTEGRATION OF LEAN MANAGEMENT AND SUSTAINABILITY

Ing. Lubica Kováčová
Technical University of Kosice
Faculty of Mechanical Engineering
Department of Materials and Technology
Masiarska 74, Košice
lubica.kovacova@tuke.sk

Abstract

Lean Production is defined as a business system for organizing and managing product development, operations, suppliers, and customer relations that requires less human effort, less space, less capital, less material, and less time to make products with fewer defects to precise customer desires, compared with the previous system of mass production. Sustainable manufacturing is defined as the creation of manufactured products that use processes that are non-polluting, conserve energy and natural resources, and are economically sound and safe for employees, communities, and consumers. Article discusses the similarities and differences between lean and sustainability. It analyses the gradual extension of the lean direction to sustainability.

Key words: Lean Manufacturing, Sustainability

INTRODUCTION

Lean management is now widely used especially in the automotive industry. Further development of lean principles is associated with sustainable development. This article addresses the issues of integration of lean and sustainability.

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The goal of Lean Manufacturing is described as “to get the right things to the right place at the right time, the first time, while minimizing waste and being open to change”. The principles of Lean Manufacturing enabled the company to deliver on demand, minimize inventory, maximize the use of multi-skilled employees, flatten the management structure, and focus resources where they were needed.

The ten rules of Lean manufacturing management can be summarized [2]:
1. Eliminate waste
2. Minimize inventory
3. Maximize flow
4. Pull production from customer demand
5. Meet customer requirements
6. Do it right the first time
7. Empower workers
8. Design for rapid changeover
9. Partner with suppliers
10. Create a culture of continuous improvement

Sustainable manufacturing is defined as the creation of manufactured products that use processes that are non-polluting, conserve energy and natural resources, and are economically sound and safe for employees, communities, and consumers.” Sustainable manufacturing includes the manufacturing of “sustainable” products and the sustainable manufacturing of all products. The former includes manufacturing of renewable energy, energy efficiency, green building, and other “green” & social equity-related products. [3]

Green, or sustainable, manufacturing is defined as a method to “develop technologies to transform materials without emission of greenhouse gases, use of non-renewable or toxic materials or generation of waste”. The term “green” often used interchangeably with “environmentally-safe”. [5]:

The viewpoint of sustainability is the opposite of financial short-term thinking. Like lean, it stresses closed-loop, cyclical thinking rather than linear, goal-oriented thinking. It actually goes even farther, into whole-system thinking, which causes practitioners to look for long-term unintended consequences of their decisions. Sustainability assumes that resources are finite, and therefore that resources should be re-used, and reused again.

SIMILARITY AND DIFFERENCES BETWEEN LEAN AND SUSTAINABILITY

Sustainability can be thought of as lean extended to a much broader objective. A company familiar with lean will easily grasp sustainability.

Lean works when individuals and teams throughout an organization start asking questions such as "How does this add value to the customer?" and, "How can we do this better?"

Sustainability works the same way —the only difference is the decision-making criteria. Rather than focusing on the economic customer, sustainability focuses on three bottom lines — profitability, people, and the planet. It focuses on the longer term, on life.
Table 1: Lean and Sustainability are Connected [3]:

<table>
<thead>
<tr>
<th>LEAN</th>
<th>SUSTAINABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long term philosophy- create value for people, community/ including environment/ economy</td>
<td>Invest in long term- consider people, community, financials, environment</td>
</tr>
<tr>
<td>Create the right process to produce the right result</td>
<td>Ensure the ecosystem is in balance, if necessary, intervene in system</td>
</tr>
<tr>
<td>Add value by developing people and partners</td>
<td>Invest in people- consider stockholders including your staff and partners/e.r. suppliers/</td>
</tr>
<tr>
<td>Continuously making problems visible a solving root causes drivers organizational learning</td>
<td>Be transparent and consider the whole system vs. treating symptoms</td>
</tr>
<tr>
<td>Minimize or eliminate waste of any kind</td>
<td>Creating waste harms something else in the system</td>
</tr>
</tbody>
</table>

For a company that has started on its lean journey, moving toward sustainability is relatively easy. Many lean tools are easily adapted and extended for sustainability, as illustrated by the following examples.

**Value Stream Mapping:** Widely used in lean thinking to see a whole picture and decide where to focus improvement efforts, it readily extends to sustainability, especially to the environmental side. Just add appropriate metrics, such as hazardous material used/generated, water used, and energy used.

**Work Teams:** Just as in lean, work teams are the heart of sustainability — they do most of the thinking, the data gathering, the analysis, the idea generating, and the implementing. And work teams, by their very nature, implement the social side of sustainability.

**5S:** For sustainability, some companies add a sixth S, Safety, and seventh S, Sustainability.

**Analysis Tools:** Teams focusing on sustainability can incorporate traditional lean analytical tools, such as Pareto charts, Ishikawa diagrams, and the “5 why’s” into their analyses. For example, hazardous material and releases of toxic substances can be analysed as if they were process defects.

**Additional Tools for Sustainability**

Table 2: Waste identification in green manufacturing [1]:

<table>
<thead>
<tr>
<th>Concept</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permit Compliance</td>
<td>Compliance with applicable permits.</td>
</tr>
<tr>
<td>Toxic Release Inventory (TRI)</td>
<td>Over 300 chemicals subject to release.</td>
</tr>
<tr>
<td>33/50 Chemicals</td>
<td>A subset of chemicals identified by the EPA as priority candidates for voluntary reductions by industry.</td>
</tr>
<tr>
<td>Clean Air Act Toxics</td>
<td>189 chemicals listed in the Clean Air Act as air toxics.</td>
</tr>
<tr>
<td>Risk-Weighted Releases</td>
<td>Toxic chemicals weighted by their relative toxicity.</td>
</tr>
<tr>
<td>Waste Per Unit of Production</td>
<td>Percentage of production lost as waste, generally measured by weight.</td>
</tr>
<tr>
<td>Energy Use</td>
<td>Total energy use by all aspects of corporate operations; also expressed as carbon dioxide.</td>
</tr>
<tr>
<td>Solid Waste Generations</td>
<td>Total solid waste going to landfills or other disposal facilities.</td>
</tr>
<tr>
<td>Product Life Cycle</td>
<td>The total impact of a product on the environment from raw materials sourcing to ultimate disposal.</td>
</tr>
</tbody>
</table>
FROM LEAN TO GREEN MANUFACTURING

The leading similarity between the benefits of lean and the benefits of green is waste, and so it makes perfect sense that in order to achieve higher levels of environmental performance, your organization must first adopt the principles and practices of lean manufacturing. Other lean concepts such as operator care; Kanban and SMED can potentially improve the environmental performance of your organization as well.

Operator care programs focused on developing standards of practice within the operating units decrease variation in the manufacturing process, which reduces the amount of product and raw materials waste.

Kanban, or pull-systems established within the manufacturing process, have greatly contributed to material and waste reductions. Kanban practices are designed to provide the right materials at the right time to support manufacturing needs. This concept focuses on reducing excess inventories of raw or work-in-process materials, which cannot be consumed immediately by the production cycle. Cell-based manufacturing processes that signal a pull for materials based on the demand for product can significantly reduce raw material consumption, decreasing the amount of waste material delivered to landfills as well as reducing the demand on raw material resources.

SMED, or single minute exchange of dies (a practice that helps your organization reduce changeover durations in order to adjust the manufacturing process based on product demand) has the potential to reduce the amount of waste generated from raw and unprocessed materials left over in the manufacturing processes.

Tools for eco-efficiently
Organizational/Management
Environmental Management Systems
Stakeholder Engagement
Corporate Environmental Reporting
Life-Cycle Management
Product Design & Development
Design for Environment
Eco-Efficiency Analysis
Life-Cycle Assessment
Of end-of-life system Environmental Risk Assessment
Integrated Product Policy (IPP)
Suppliers/Purchasing
Environmental Supply Chain Management
Green Procurement
Marketing and Communications
Corporate Environmental Reporting

Eco-Labeling
Stakeholder Engagement
Production & Distribution
Eco-Efficiency Analysis
Industrial Ecology
Pollution Prevention
Life-Cycle Costing
Facilities Management/Project Development
Green Building Design
Environmental Impact Assessment
Environmental Management Systems
Stakeholder Engagement

Life Cycle Assessment-LCA
A decision-making tool to identify environmental burdens and evaluate the environmental consequences of a product, process or service over its life-cycle from cradle to grave standardized by the International Organization for Standardization forms the conceptual basis for a number of management approaches that consider a product across its life-cycle, covering resource acquisition, product manufacturing, product use, and end-of-life LCA – key elements:

- Consideration of multiple life cycle stages.
- The physical sequence of operations in a product system, cradle-to-cradle or earth-to-earth.
- The primary stages are materials acquisition and processing, manufacturing, use and end-of-life disposal within each of these stages; sub stages or unit processes are defined.
- Consideration of multiple environment and resource issues.

LCA studies expose trade-offs by analysing significant inputs from the earth and outputs to the environment across the various life-cycle states. An assessment or interpretation of the significance of the results can vary from aggregation of data into a set of simple indicators to the consolidation of the data into a core set of indicators using a variety of weighting or scoring methods. LCA can help decision-makers to:

- Identify unintentional impacts of actions (e.g. upstream GHG emissions that may offset perceived benefits of a new technology).
- Ensure consideration of all environmental media across the life-cycle (e.g. equal consideration of emissions to air, water and land during project construction, operation and decommissioning).
- Avoid shifting problems from one life-cycle stage to another, from one geographic area to another and from one environmental medium to
another (e.g. ensuring an air pollution mitigation measure does not create a water pollution problem elsewhere in the system).

- Identify opportunities to improve the environmental and economic performance of the technology, project, product or service in question (e.g. identifying “hotspots” that need to be addressed).
- Communicate more effectively with stakeholders on the system wide consequences of project or technology options (e.g. to communicate full impacts and/or benefits of changes to a product system).

**Design for Environment (DfE) or Eco-design** The integration of environmental considerations into product and process design. Fundamental to DfE is the use of tools and practices that encourage environmental responsibility and simultaneously reduce costs promote competitiveness and enhance innovation. DfE practices are meant to develop more environmentally compatible products and processes while maintaining (and in some cases even exceeding) price, performance and quality standard.

**Key elements of DfE are:**

- Selection of low-impact materials.
- Reduction of energy use.
- Optimisation of production techniques.
- Optimisation of distribution system.
- Reduction of use phase impacts.
- Optimisation of initial lifetime.
- Optimisation.

**Apply DfE/eco-design is important:**

- At the front end of the product development process (e.g. at the planning and conceptual design phase).
- Often the design strategies are informed by prior analytical work on the life cycle cost and environmental impacts of the previous generation of products.
- In innovation processes DfE may be used to inform product design (e.g. material selection) through the use of design checklists.

**Cleaner production/pollution prevention.** The continuous application of an integrated preventative environmental strategy applied to processes, products and services to increase eco-efficiency and reduce risk for humans and the environment. For processes, cleaner production includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes before they leave a process. For products, the strategy focuses on reducing impacts along the entire life cycle of the product, from raw material extraction to the ultimate disposal of the product. Cleaner production – key elements Cleaner production is a broad term encompassing the following concepts:

- Waste minimization and avoidance
- Pollution should be prevented or reduced at the source whenever feasible
- Environmental management, Substitutions for toxic and hazardous materials
- Process and product modifications
- Internal reuse of waste products

**Environmental Management System (EMS)** The organizational structure, responsibilities, practices, procedures, processes and resources for implementing and managing an organization’s environmental affairs while ensuring conformity to its policies, standards and stakeholders’ expectations. EMS – key elements:

- **Purpose** – an organization should have an identifiable purpose, which is usually stated as its goals and objectives and encapsulated in the organization’s environmental policy, **Commitment** – there should be a sense of commitment and accountability among the people in the organization with respect to taking the appropriate action in support of the EMS.

- **Capability** – the organization should have the necessary resources (human, physical and financial) as well as the knowledge and skills to achieve the organization’s environmental policy. **Learning** – the organization should strive to continuously learn to improve its own management and learning processes through monitoring and measurement of environmental performance, efficient internal and external communication as well as review of the EMS by senior management.

While there has been an increased awareness of EMS due to the creation of the international standard on EMS (ISO 14001) it is important to understand there are a variety of EMS’s in use by industry such as Responsible Care in the chemical industry, the EU standard EMAS and others.

**References**


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