

Integration Of Lean-Green Manufacturing Practices To Towards Environment Friendly Products: Plastic Industry

Mrs Rimalini Ashish Gadekar¹, Prof (Dr) Ashish Gadekar²

¹Department of Mechanical Engineering, Government Polytechnic Nagpur

²Professor in Management, Department of Management Studies

Abstract :- Toyota's Production System (TPS) ^[21] is the origin of the Lean manufacturing concept that was introduced in the early 1990s ^[1]. The concept is widely accepted among scholars and supposed to contribute to sustained competitiveness. Strong focus is set on value creation and waste reduction in the manufacturing processes.

"Lean Production is a system of work organization that strives to deliver high quality, low-cost products through the efficient use of resources and the elimination of waste." ^[20]

Lean manufacturing relies on certain principles such as standardized processes, Levelled production, JIT practices, visual inspection, and Continuous improvement^[2] Above four research propositions on how the Lean philosophy can contribute to more long-term and sustainable competitive impact. None of these propositions, however, include environmental issues.

More recently, the Green manufacturing concept has entered the agenda as a response to negative environmental impacts caused by manufacturing activities. This concept focuses mainly on reducing effects on the natural environment and a number of principles have been outlined: reduction of energy use, reduction of material waste and emissions, use of recyclable materials, fewer manufacturing steps, new manufacturing technology, environmental training, etc. However, the Lean and Green manufacturing concepts have evolved rather independently and there is a need to "unpack the nature of the relationship between lean and green." ^{[3]. [4]}

The research examines the concept that Lean and Green manufacturing secures both economic and environmental sustainability for the long-term growth and prosperity of the Plastic Industries in India by improving productivity whilst minimising the environmental impact of its activities.

Key Words: Lean Production, Elimination of Waste, Visual Inspection, Lean Philosophy

I. BACKGROUND OF STUDY

With a population over one billion, 40% under age 15, opportunities for plastics producers in India include near-term rapid growth in the nation's internal consumption of plastic products. The Indian middle class is 300 million and rising, and the annual GDP growth rate is 8%.

In addition, the national goal of becoming a manufacturing hub similar to China may present opportunities for plastics producers in all parts of the value chain. Growth in the plastics industry in India is expected to average double-digit rates within five years.

Jim Morton, a Senior Partner at Principia explains "For perspective, per capita plastic consumption in North America is about 200 pounds; in China, 50 pounds. Plastic consumption in India is less than 15 pounds per capita, but will reach over 40 pounds by 2015. Widely accepted projections foresee explosive growth in the general consumption of plastics for applications ranging from disposable products to automotive parts to super-durables such as building products."

While the plastics industry structure in India is characterized by many low volume processors and manufacturers, consolidation has already begun, which is often a precursor of industry growth characterized by both greater volumes and higher margins, based on economies of scale. Many expect India to become a manufacturing hub rivaling China for production capacity and for feeding export markets with finished goods.

The Indian plastics industry is quite upbeat about the future potential of plastics in India, believing that the Plastics industry will grow between 10% to 12%, if not higher, in this decade. The present per capita consumption is 4 Kgs, likely to reach beyond 7 Kgs by 2010. Consumption level, which is expected to reach 8 million tons by 2010, could touch 10 million tons, if some of the constraints such as infrastructure etc are eliminated. The department of petrochemicals of the Government of India has projected a level of 12 million tons by 2011/2012 [18].

Toxic gases and chemicals are emitted into the air or discharged into the water in the process of producing plastics, which eventually generate negative environmental and human health effects. The kind of emissions or effluents generated and their toxicity varies depending on the type of plastic being made. Nevertheless, the toxic chemicals that are most frequently released during the production of plastics include trichloroethane, acetone, methylene chloride, methyl ethyl ketone, styrene, toluene, benzene. Other major emissions include sulfur oxides, nitrous oxides, methanol, ethylene oxide, and volatile organic compounds. Benzene is believed to cause cancer, styrene has been ranked in the US as extremely toxic, sulfur oxides are known to harm the respiratory system, nitrous oxides adversely affect the nervous system and child behavioral development and ethylene oxides harm the male and female reproductive capacity [6].

Above mentioned points has urged for the urgent attention of the researchers. Integration of Green and Lean may lead to the perfect solution as the need of an hour.

II. CURRENT STATUS OF LEAN AND GREEN MANUFACTURING IN PLASTIC INDUSTRY

United Plastics Group's (UPG Suzhou (China)) lean manufacturing initiative, which began late last year, has produced solid results including reduced costs, decreased time-to-market, decreased manufacturing cycle times and increased productivity.

"Making continuous improvements across all of our world-class manufacturing plants enables us to quickly deliver the highest quality products to our customers". [17].

China Plastics Machinery Industry The "green" theme highlighted at the Chinaplas 2010 trade show covers many categories of products. For injection moulding machines, the "greenness" is measured and certified by third party organizations. In fact, the recently-developed Chinese standards for energy-saving injection machines are quite lofty, compared to, for instance, the German equivalent. Machinery makers have been increasingly touting the energy-saving features of their products in recent years, but there was no system in place to regulate these claims, according to Qian Yaoen, general secretary of the China Plastics Machinery Industry [22]

The preview findings of the study, which has been funded by Plastics Europe and was carried out by independent **Austrian sustainability consultancy Denkstatt**, show the use of plastics saves 2,300 million GJ in energy a year. This equates to 50 million metric tons of crude oil the contents of 194 oil tankers or 120 million metric tons of greenhouse gas emissions. [22]

One key principle of Lean production is the reduction of wasted materials and labor in a continuously improving culture [14]. To see if Lean companies naturally tend to be Green, known Lean manufacturers were surveyed to determine if they were transcending to a more Green state as a result of their commitment to Lean production. The Lean manufacturers included in the study were plant sites that received site visits from the **Shingo Prize team** during the years 2000 through 2005 as part of the process of applying for the Prize. This sample was 120 individual manufacturing plants, from which 47 usable surveys were received [13]. The data from this sample was compared to

similar data published by Melnyk, Sroufe, and Calantone ^[15] regarding the Greenness of roughly 1100 general manufacturing plants in the US.

Measures of Leanness were derived from Shingo Prize evaluations of the plants ^[16]. Our results are staggering in that Shingo companies score significantly higher than the general population of manufacturers studied by Melnyk, et.al ^[15]. This makes a very powerful statement that Lean companies are embracing Green objectives and suggests that Lean manufacturers are transcending to Green manufacturing as a natural extension of their culture of continuous waste reduction, integral to world class Lean programs.

III.SIGNIFICANCE OF THE RESEARCH

- The research is focused on establishing correlation between Lean and Green Manufacturing exploring the enormous potential for India.
- The research is focused on factors responsible for Lean and Green products. The important factors are sustainable development, cost benefits, resource reduction and manpower/special skill requirement, waste management etc.

IV.AIMS AND OBJECTIVES OF RESEARCH

After exploring lean and Green manufacturing in all dimensions the researcher proposed following objectives of the research were been elaboratively focused. First of all we started from understanding lean and green manufacturing application status in Indian Plastic Industry. Then establish understanding and application of tools of lean and Green Manufacturing Technique in general. This lead to know the reasons for not implementing lean and green manufacturing in Indian Plastic Industry also the motives of implementing Lean and Green Manufacturing. Few live cases where Lean and Geen Manufacturing is implemented and being practiced in Indian plastic Industry gave us real time knowledge of the field Finally before validating analyzed various critical success factors and Performance measure factors, for lean and green manufacturing implementation in Indian Plastic Industry. Validated the comprehensive roadmap / framework with the case studies. The data was collected through literature survey, interviews, group discussions, questionnaires, seminars, short term training program, journals, conferences etc.

V. FOLLOWING HYPOTHESIS TESTED

1. Integration of Lean and Green Manufacturing shall contribute positively in sustainable development.
2. Integration of Lean and Green Manufacturing shall positively impact competitiveness of Indian plastic Industry.
3. Integration of Lean and Green Manufacturing shall provide large employment.
4. Integration of Lean and Green Manufacturing shall trigger price reductions.
5. Integration of Lean and Green Manufacturing shall help retard/reduce global warming.

VI.DATA PRESENTATION AND DATA ANALYSIS

The data from 68 companies was studied from MIDC Nagpur, MIDC Pimpri – Chinchwad.

Following is the data analysis report generated through SPSS 20. First the questionnaire was passed through the reliability test. We carried out the face and content reliability. We served the questionnaire to 5 professionals from the industry as well as consultant in the field. This was for carrying out the face validity. And after this Cronbach Alfa value was calculated. We obtained a very promising value of 0.805 we concluded the research tool is measuring what it should measure.

Reliability

Scale: Content Validity

Case Processing Summary

		N	%
Cases	Valid	68	100.0
	Excluded ^a	0	.0
	Total	68	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.803	.805	5

The central tendency of the data was calculated to locate the values pertaining to data analysis. The Likert scale was used. 1: Very Low, 2: Low, 3: Ok, 4: High, 5: Very High. The mean found is ranging between 3 to 4 conveys that FIVE variables under study has average opinion towards more than high side.

Mean value of 3.8529 for variable Sustainable development through the implementation of LEAN-GREEN practices. This means the companies believe in the prospective growth through the Environment friendly practices.

Further mean value of variable LEAN-GREEN Practices value 4.1176 strengthens the claim that the plastic industry India is aggressively looking forward for environmental care

Variable Price mean value of 3.0294 shows it is not the significant factor of the industry to make the decision in favor of LEAN –GREEN Practices.

Mean values for various variables under study:

Item Statistics

	Mean	Std. Deviation	N
SustDevp	3.8529	1.12322	68
LeanGreen	4.1176	1.08627	68
EmpLevel	3.7647	1.00918	68
Price	3.0294	1.23350	68
EnvironImpact	3.7941	1.03027	68

Inter-Item Correlation Matrix

	SustDevp	LeanGreen	EmpLevel	Price	EnvironImpact
SustDevp	1.000	0.612	0.338	0.240	0.378

LeanGreen	0.612	1.000	0.411	0.25	0.378
EmpLevel	0.338	0.411	1.000	0.242	0.519
Price	0.240	0.25	0.242	1.000	0.183
EnvironImpact	0.378	0.378	0.519	0.183	1.000

The correlations between Sustainable Development with Lean-Green Practices is 0.612 shows that the plastic Industry in India is looking forward to Lean-Green Practices

VII. FINDINGS

A number of companies have started adopting Green initiatives as an integral part of their operations. These initiatives are driven by eight factors:

1. Consumer Awareness
2. Rising energy and input costs
3. Growing consumer pull for Green products
4. Global competition
5. Increasing regulatory pressures as policy makers introduce new and stricter environmental and waste management laws.
6. Resource Scarcity
7. Technological advances which open up new attractive business opportunities
8. The need to enhance competitive differentiation, particularly for first movers or those who are able to break the compromise between short-term higher costs and numerous benefits (example: brand premium, new customer segments)

VIII. CHALLENGES IN ADOPTING LEAN – GREEN

1. Approaching Green as limited, often isolated initiatives.
2. Educating consumer.
3. Meeting regulatory compliance to developing eco-advantage.
4. Product Costing.
5. Companies don't fully understand drivers and issues relevant to them and their industries, and what sustainability means to them.
6. Companies face difficulties in modeling the business case – or even finding a compelling case for sustainability.
7. Even the companies that adopt Green initiatives perform these activities as peripheral to their core business and not integrated into their corporate strategy. Hence the execution is flawed and they fail in realizing the full benefits.
8. Green Labeling
9. Green Washing
10. Government Policies

IX. COMPARATIVE MODELS OF LEAN AND GREEN SYSTEMS

A small number of scholarly studies have investigated the relationship between Lean and Green manufacturing systems [25, 26, 27]. These studies show a positive relationship between Lean and Green. Each shows correlation between some elements of a Green manufacturing system and some aspects of a Lean manufacturing system. The Florida study [26] found that progressive companies applied advanced management practices (e.g. management commitment, teams, new process

technology, innovative product design, supply chain management) toward minimizing environmental waste. Dr. Florida indicated that these techniques are associated with both Lean and Green manufacturing systems. “Advanced manufacturing facilities, such as those organized under the principles of lean production, draw on the same underlying principles – a dedication to productivity improvement, quality, cost reduction, and continuous improvement, and technology innovation – that underlie environmental innovation [26]

Since both Lean System models and Green System models tend to emphasize the importance of the management system, the application of various waste reduction techniques, and the achievement of desired business results, we have recognized that there is great similarity in the structure of such models. Indeed, many of the elements of the models are very similar if not identical. While each study established meaningful correlations between various components of the model, none performed a full correlation analysis of the entire model. Figure 1 provides a comprehensive comparative model.



Figure: Comprehensive Comparative Model

VIII. CONCLUSION

The Chairman of ITC — spoke about implementing a totally new paradigm of competitiveness based upon creation of ‘Green businesses’ and also the generation of ‘Green livelihoods’. He went on to say that in the future, “...competitiveness and profitability will be increasingly linked to the ability of business to make carbon reduction and the creation of sustainable livelihoods an integral part of their value proposition to consumers...” Similarly, the Godrej Group has set up a Mission on Sustainable Growth task force led by a very senior leader of the firm.

The transformation journey to Green manufacturing has just started. While there are a few early adopters, the industry at large needs to develop comprehensive plans to address all three areas — Green energy, Green products and Green processes. The prize for success is enormous for both individual manufacturing companies and the country as a whole. Failure is no more a choice. This study has yielded undeniable similarities between them. Having shown the parallel nature of Lean and Green Systems, we leave to other articles the tasks of exploring the relationships between Lean and Green Systems. High degree of correlation is exposed in various variables like waste reduction, employability, eco friendly packaging between green and lean manufacturing.

References

- 1) Womack J.P., Jones, D.T. and Roos, D. , The Machine That Changed the World, Rawsons Associates, NY.Womack, 1990

- 2) Lewis, M. "Lean production and sustainable competitive advantage", *International Journal of Operations & Production Management*, vol. 20, No. 8, pp. 959-978. 2000
- 3) King and Lenox, "Lean and Green? An empirical examination of the relationship between lean Production and environmental performance." *Production and Operations Management*, Vol. 10, No. 3, pp. 244-256. (2001)
- 4) Lean vs. Green manufacturing: Similarities and differences *Department of Industrial Engineering and Management, School of Engineering, Jönköping University, Sweden Division of Operations Management, Department of Technology Management and Economics, Chalmers University of Technology, Goteborg, Sweden.
http://www.plasticsresource.com/plastics_101/manufacture/how_plastics_are_made.html
- 5) Letter written by Tim Krupnik of the Berkeley Ecology Center to Dr A N Bhat of ICPE supporting the attempt to ban disposable plastics in India, March 15, 2001. Bharati Chaturvedi, Director, Chintan Environmental Organization, New Delhi.
- 6) Swedish Waste Management -Annual Publication of RVF, RVF - The Swedish Association of Waste Management , 2000
- 7) Waste Technology, Waste to Energy Project in India, Asian and Pacific Centre for Transfer of Technology, New Delhi, Volume 5, Number 44, 2001.
- 8) Tammemagi H. —The Waste Crisis: Landfills, Incinerators and the Search for a Sustainable Future Oxford University Press, New York. 1999
- 9) A press release of NOPE (No Plastics in the Environment) titled —Imports Versus Surplus: A Glut of Plastics in India Today, January 10. Bharati Chaturvedi, Director, Chintan Environmental Organization in New Delhi. 2002
- 10) D'Mello, P Plastic Bag Problem the Asian Age accessed at <http://www.goacom.com/news/news98/jun/msg00043.html>.
- 11) Amaral, K. —Plastics in Our Oceans accessed at <http://www.umassd.edu/Public/People/Kamaral/thesis/plasticsarticle.html>.
- 12) Bergmiller, G.G., "Lean Manufacturers Transcendence to Green Manufacturing: Correlating the Diffusion of Lean and Green Manufacturing Systems," PhD Dissertation, University of South Florida. 2006
- 13) J. Sarkis, "Manufacturing's role in corporate environment sustainability: concerns for the new millennium", *International Journal of Operations & Production Management*, Vol. 21, No. 5/6, pp. 225-248. 2002.
- 14) A. A. King, and M. J. Lenox, "Lean and green? An empirical examination of the relationship between lean production and environmental performance", *Production and Operations Management*, Vol.10, No. 3, pg. 244-257, 2001.
- 15) H. Griese, J. Muller, L. Stobbe, H. Reichl and K. Rick, "Strategies to integrate life cycle engineering into technological developments-the 3G Greenbook Initiative", *IEEE International Symposium on Electronics and the Environment*, pp. 25 – 29, 2003.
- 16) <http://www.allbusiness.com/company-activities-management/management/5905156-1.html>.
- 17) http://www.plastemart.com/upload/literature/246_art_synopsis.asp.
- 18) <http://www.plastemart.com/upload/home/icpe.asp>.
- 19) <http://www.lir.msu.edu/piers/leanproduction.htm>, The School of Labor
- 20) Toyota Production System terms," Retrieved May 21, 2006, from <http://www.toyotageorgetown.com/terms.asp>.
- 21) PLASTICS NEWS • 'Report on AIPMA delegation to CHINAPLAS 2010'
- 22) Bergman, L., Hermann, C., Stehr, J., & Sebastian T, An Environmental Perspective on Lean Production. *The 41st CIRP Conference on manufacturing Systems*, 2008.
- 23) G. Miller; J. Pawloski; C. Standridge, Geoff Miller¹, Janice Pawloski², Charles, A case study of lean, sustainable manufacturing 11 EPA, , Lean Manufacturing and the Environment, Office of Solid Waste and Emergency Response, 2003
- 24) United States Environmental Protection Agency, EPA100-R-03-005.Florida, R., 1996, Lean and Green: the Move to Environmentally Conscious Manufacturing, Regents of the University of California.
- 25) King, A., and Lenox, M., "Lean and Green? An Empirical Examination of the Relationship Between Lean Production and Environmental Performance," *Production and Operations Management*, 10(3), 244-257, 2001
- 26) Proceedings of the 2009 Industrial Engineering Research Conference, Parallel Models for Lean and Green Operations, Gary G. Bergmiller & Paul R. McCright
- 27) <http://115.113.225.49/webcms/Upload/BCG-CII Green Mfg Report.pdf>
- 28) J.P. and Jones, D.T, Lean Thinking, Simon & Schuster, NY. 1996

