Journal of Advances in Science and Technology
Vol. 12, Issue No. 25, (Special Issue) December-2016, ISSN 2230-9659

An Organizational Practice of Lean & Cleaner Production in Packaging and Printing Sector

K. Rajesh[1]*, Dr. C. N. V. Sridhar[2], P. Pavani[3]

[1]Assistant Professor

Abstract – Lean and cleaner production has gained increasing attention within both academia and industry. As the literature grows, finding new directions by critically evaluating the research and identifying future directions becomes important in advancing knowledge for the field. Today, industries such as printing and packaging sectors deal with lot of environmental issues and regulations. Lean and clean are the key factors towards effective utilization of resources. The paper details the environmental issues and describes the best practice to improve environmental performance that naturally results from industrial activity.

Index Terms—Cleaner Production, Environment Issues, Lean Management, Organizational Theory.

----------♦----------

1. INTRODUCTION

The printing and packaging sector has come under increasing pressure from the customers and government to reduce its impact on the environment. This has lead to increased costs for waste disposal and the necessity to comply with various licensing controls. The printing and packaging sector covers various media which include: paper and plastic bags,film,corrugatedpackaging,cartons,labels,magazines,newspaper,books and tapes. In order to make improvements it is first necessary to assess current performance in relation to the main environmental issues.

2. LITERATURE REVIEW

Organizational theory

Organizational theory is in the early phases of broad introductions and applications into operational management [10].In addition, sustainability and environmentally focused research in management disciplines and business disciplines traditionally outside an organizational management. It has introduced broad applications to a number of disciplines.

Environmental waste

Environmental waste [6] is an unnecessary or excess use of resources or a substance released to the air, water or land that could harm human health or environment. Environmental waste can occur when companies use resources to provide product or services to customers and/or when customers use and dispose of products. Environmental waste does not add value to the customer. It can also directly affect the production flow, time, quality and cost-making those targets for lean initiatives. In many cases the costs associated with pollution and wasted energy, water and raw material can be significant. Some environmental waste are easy to see such as containers of solid and hazardous waste are visual indications of environmental waste. It can found in almost any process require environmental permits such as paintaing,metal finishing,packaging,printing are often a good place to look for environmental improvement oppurtunities.If the organization has EMS, environmental, health and safety personnel may have already identified key environmental impacts associated with each of the organization's processes.

Packaging

Packaging [8] is a process of covering, wrapping of goods into a package. Packaging involves designing and producing the wrapper for a product. It is next to grading and branding and is essential for offering goods in safe and secured position to consumer. Consumer packaging is designed for convenience and appeal, marketing considerations and display which mainly emphasis on marketing. Industrial packaging is focused on convenience and protection during transportation and mainly emphasis on logistics. The primary functions of packaging are representation, protection, preservation, economy and convenience. The secondary functions are containment, identification, suitability, labeling and handling.

Printing

Printing is a process of reproducing texts and images on plain surfaces such as paper. This process is attained using ink and printer. It may be performed either on small or large scale. The earliest kind of text and image reproduction was the ancient woodblock process. This rudimentary kind as ever since gradually been replaced with the effective modern day printing press. Printers are the major devices utilized in this process. Printing has undergone a lot of advancement recently. There are many different printing techniques in the global market depends upon the specifications [9].

3. LEAN MANAGEMENT

Lean manufacturing is an efficiency based system on optimizing flow to minimizing the wastage and using advance methods to improve manufacturing system by modified or change pre-existing ideas [2]. Another definition say that Lean Manufacturing is a philosophy that aims to maintain smooth production flow by continuously identifying and eliminating waste resulting in increasing value of activities in the production process. Lean manufacturing approach makes an organization able to sustain market competition by improving its competence for better quality on time delivery with lower cost. Lean Manufacturing aims for Identification and elimination of waste (any activity that does not add value to customer) [1]. Lean manufacturing aims to continuous flow of all manufacturing processes with minimum as minimum wastage.

The Basic Elements of Lean Manufacturing System are [3]: KANBAN, TPM (Total Productive Maintenance), JIT (Just In Time), KAIZEN (Change For Better), Quality Circles, TQM, Employee Involvement and 5's. The main benefits of Lean Manufacturing System are [3]: Improve productivity, overall wastage reduction, Cost reduction, Reduce defects, and Overall quality improvement. Lean is shorthand for focusing on effectiveness and efficiency across all areas of a business. Lean works most effectively where it has become the way of doing business, where it is a fundamental part of the business strategy and not just "using some tools". Lean does this by focusing on finding and removing waste. Nobody wants to do wasteful things, or spend their day doing no-value work. The Lean Approach provides people with the tools to help them and their companies to find hidden wastes and to tackle them.

4. CLEANER PRODUCTION

In the past, companies have often introduced processes without considering their environmental impact. They have argued that a tradeoff is required between economic growth and the environment, and that some level of pollution must be accepted if reasonable rates of economic growth are to be achieved. This argument is no longer valid, and the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in June 1992, established new goals for the world community that advocate environmentally sustainable development. Over the years, industrialized nations have progressively taken different approaches to dealing with environmental degradation and pollution problems ignoring the problem, diluting or dispersing the pollution so that its effects are less, harmful or apparent, controlling pollution using 'end-of-pipe' treatment. The gradual progression from 'ignore' through to 'prevent' has culminated in the realization that it is possible to achieve economic savings for industry as well as an improved environment for society. This, essentially, is the goal of cleaner production [4]. Cleaner Production is defined as the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase overall efficiency and reduce risks to humans and the environment. In case of production processes, cleaner Production involves the conservation of raw materials and energy, the elimination of toxic raw materials, and the reduction in the quantities and toxicity of wastes and emissions.

Environmental issues are complex, numerous and continually evolving, and an adhoc approach to solving environmental problems is no longer appropriate. Companies are therefore adopting a more systematic approach to environmental management, sometimes through a formalized environmental management system (EMS). An EMS provides a company with a decision-making structure and action programme to bring cleaner production into the company's strategy, management and day-to-day operations.

Investing in Cleaner Production, to prevent pollution and reduce resource consumption is more cost effective than continuing to rely on increasingly expensive 'end-of-pipe' solutions. When cleaner production and pollution control options are carefully evaluated and compared, the cleaner production options are often more cost effective overall. The initial investment for cleaner production options and for installing pollution control technologies may be similar, but the ongoing costs of pollution control will generally be greater than for cleaner production. Furthermore, the cleaner production option will generate savings through reduced costs for raw materials, energy, waste treatment and regulatory compliance. Some reasons to invest in cleaner production are improvements to product and processes; savings on raw materials and energy, thus reducing production costs; increased competitiveness through the use of new and improved technologies; reduced concerns over environmental legislation; reduced liability associated with the treatment, storage and disposal of hazardous wastes; improved health, safety and morale of employees; improved

company image; reduced costs of end-of-pipe solutions [4].

Types of cleaner production techniques in any production processes are [4]:

TABLE I

Sl.no	Types	Description
01	Housekeeping	Improvements to work practices and proper maintenance can produce significant benefits. These options are typically low cost.
02	Process optimization	Resource consumption can be reduced by optimizing existing processes. These options are typically low to medium cost.
03	Raw material substitution	Environmental problems can be avoided by replacing hazardous materials with more environmentally being materials. These options may require changes to process equipment.
04	New technology	Adopting new technologies can reduce resource consumption and minimize waste generation through Improved operating efficiencies. These options are often highly capital intensive, but payback periods can be quite short.
05	New product design	Changing product design can result in benefits throughout the life cycle of the product, including reduced use of hazardous substances, reduced waste disposal, reduced energy consumption and more efficient production processes. New product design is a long-term strategy and may require new production equipment and marketing effort.

5. RELATIONSHIP BETWEEN LEAN AND CLEAN

The need for lean and clean must eliminate waste in order to reduce cost and become more responsive to customer needs, greater pressure on companies to minimize environmental impact, growing trends to market focusing on environmentally friendly products. Lean and clean are highly complementary words which focus on systematic and on-going efforts to identify and eliminate waste, seek active employee participation in improvement activities, seek engagement with the supply chain to improve enterprise wide performance, create a competitive advantage as customers increasingly expect products/services with less environmental footprint [6].

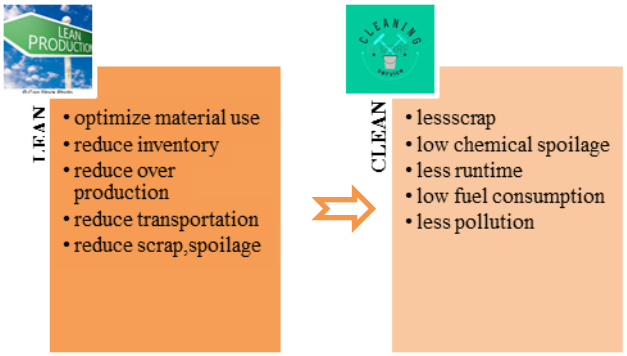

Fig. 1. Relationship between lean and clean methodology

6. ENVIRONMENTAL ISSUES

In order to make the improvements, it is first necessary to assess current performance in relation to the main environmental issues. The current, most environmental issues faced by the printing and packaging sectors are as follows[5]:

A. Material storage

Printing and packaging companies typically store environmentally hazardous material for use on-site. The majority of sites in this sector do not have correct storage facilities for all materials which can lead to adverse environment impacts. Materials use and storage should be in accordance with the relevant Material Safety Data Sheet (MSDS). Chemicals, oils, solvents etc. should be stored in adequately banded areas. In addition to safe storage, it should be ensured that the loading, unloading and transfer of materials are carried out in designated areas protected against spillage and leachate run-off. Examples include: The transfer of hazardous materials around the site should be carried out on drum trolleys with a sump to prevent accidental spills. A spill response kit should be located on-site and staff should be trained in its proper use and disposal of spent absorbents. Have a designated, clearly marked area protected against spillage for delivery of hazardous materials e.g. this area should be banded. All deliveries of hazardous materials should be supervised during loading or unloading. The transfer of hazardous materials around the site should be carried out on drum trolleys with a sumo to prevent accidental spills.

B. Waste

The major problem experienced by companies in this sector is lack of waste segregation. This hinders re-use and recycling and can often lead to the least-preferred option of disposal of large volumes of waste (including hazardous) to landfill. Good waste management practice requires the segregation of waste types into separate waste storage bins or

storage areas (which may be labeled and colour-coded for ease-of-use by workers). Employees should receive training in correct segregation practices and regular site inspections should be undertaken to check that waste is being properly segregated. A company's current performance regarding its waste practices can be determined in various ways e.g.: make-ready waste is probably the largest area of waste; it can be measured using the following method: 1.Quantify: Set up a special bin at the side of each press to collect spoilage.2. Analyse the loss from the job (weight or number of sheets). Calculate the percentage loss.3.Plot a graph to help trace losses (this should highlight a reduction over time).4.Record the reasons for losses. It is also a useful exercise to evaluate waste management costs out of total expenditure.

C. Effluent discharge

The main method of generating trade effluent by this sector is during cleaning i.e. wash-down of equipment, rollers, screens, plates, etc.

D. Solvent usage

Volatile Organic Compounds (VOCs) are emitted from solvent-based ink and materials used by the printing and packaging sector. Not managed properly VOCs can be dangerous. These risks include [7]:

1. Environment: Use less hazardous alternatives for cleaning e.g. water-based cleaner should be used instead of solvent when suitable. The effects of VOC emissions to atmosphere from this sector are considered a significant issue. In the presence of sunlight and Nitrogen Oxides (NOx), VOCs react to form ground-level ozone, a component of smog. Ozone is very toxic and it affects breathing and the eyes. (In the higher atmosphere, it is beneficial, forming a protective ozone layer). Smog has wide-ranging effects. This brown haze has the greatest impact on the air quality in urban areas. It can corrode buildings and machinery. Crops and leaves are damaged, and growth is reduced. Susceptibility to insects and disease increases. Smog also accelerates the deterioration of rubber products. Emissions from VOCs can also be responsible for odour pollution which can cause public complaints, bad publicity and the possibility of breach of legislation.

2. Health risks: Many VOCs act as irritants or carcinogens.

3. Financial: Most solvents are very expensive to buy and to dispose of as they are generally classified as hazardous waste.

Benefits of reducing solvent use: A reduction of solvent use has significant advantages for companies; these include both economic and environmental improvements e.g.: cost benefits through reduced purchasing costs and waste disposal charges, reducing solvent use to below the thresholds for Licensing requirements (EPA Acts 1992 to 2003 and the Solvent Regulations),reduced insurance premiums due to lower solvent stock on site, safer working environment for employees and reduced potential for spillages. Current solvent usage should be measured to provide a baseline from which the solvent consumption figure should be reduced. Estimate the solvent inputs and outputs to track solvent usage i.e. inputs include purchases and stock on-site, and outputs consist of emissions to atmosphere, discharges to water and waste. Areas of loss can be highlighted and an action plan can be established to target areas of solvent reduction.

E. Emissions to atmosphere

The control of VOCs emissions from printing facilities is important because of the recently implemented Solvents directive, which controls the emissions of VOCs.

6. BEST ORGANIZATIONAL PRACTICE MANAGEMENT TECHNIQUES

For printing and packaging [5] sectors the best guidelines to be followed as per EPA to get sustainability are:

Material storage

It is important that correct handling and storage procedures are known to all employees and are followed at all times. The correct storage of ink and other hazardous materials on-site reduces the risk of surface water / groundwater / soil contamination in the event of an accident; eliminates costly clean-up in the event of an accident; reduces negative exposure in the event of a spill; incorporates best practice in the operation of the site.

Waste (Process & packaging)

In order to incorporate Best Practice Waste Management into site operations, the Waste Management Hierarchy should be adopted i.e. in increasing order of preference:

Fig. 2 Waste Management Hierarchy

The main types of process waste generated include waste substrate, ink and packaging waste. Best practice management options to help avoid or reduce these waste types in various stages of the production process are discussed below:

1. Substrate: estimating and ordering: When ordering, specify metal reel cores instead of cardboard as these can reduce damage to reels. Consider doubling up jobs by printing two different jobs on one sheet to utilize the greatest area possible on the sheet. Delivery & Storage: Check incoming substrate to ensure its quality and specification is correct; if not, return to supplier. Store pallets and reels singly, instead of on top of each other, to reduce the risk of damage when substrate is moved. Keep reel ends covered until press set-up to reduce damage and prevent deposition of dust. Press Set-up & Make-ready: Ensure customers' requirements have been interpreted correctly to prevent generation of waste. Use lower quality substrate or spoiled sheets from previous press runs for the initial press set-up / make-ready. Press Run: Monitor colour and ink density during printing to detect errors quickly. Train employees to operate the press correctly and correct errors without delay. Cutting & Binding: Avoid cutting too many sheets at a time, as this can result in poor quality cuts and edges. Make operators aware of the maximum quantity of substrate that can be cut at a time. Ensure blades, knives and dies are sharp to make clean cuts; implement a procedure to check regularly. Ensure that binding machines are lined up correctly and that sheets are loaded in the right order by including checking procedures at the binding stage.

2. Ink: Printing inks are expensive and any opportunities to minimize waste ink can help save money. Waste ink is generated through color changes, press cleaning and poor ink management, which allows drying and skinning. However, effective management techniques can help reduce waste ink. Don't treat excess ink as waste; instead, manage it like a product that should be reintroduced into the system when possible. Estimating & Ordering: Help press operators accurately estimate the amount of ink needed for each job through training in ink estimating techniques. Keep accurate records of the quantity of ink that is used for specific jobs, particularly for re-orders or repeat customers. Delivery & Storage: Keep ink containers sealed and contents level; place plastic or wax paper on top of the ink to prevent drying; use anti-skinning sprays (also useful on open ink wells on the printing machines). Always close lids after use. Carefully monitor inventory to ensure a "first in-first out" strategy. Ensure correct storage temperature to prolong the shelf-life of many inks. Ink mixing: Consider installation of a computerized ink mixing system. Otherwise, to reduce waste costs, try to identify a company with an ink mixing facility which would be willing to take left-over ink for recycling. Press Set-up & Make-ready: Assess the feasibility of installation of digitized ink duct settings on presses. Press Run: Use a standard ink sequence and try to schedule print runs from light to dark, if possible. Ensure a sufficient number of quality checks at the correct stages of the process, to identify earliest opportunity for remedial action if necessary.Clean-down: Use anti-skinning measures on rollers to reduce the number of wash-downs required. Closed ink fonts reduce the degree of ink blocking and contamination, and hence the number of wash-downs needed. Ink recycling: Scrape as much ink from empty containers as possible prior to disposal or recycling. Blend waste inks of different colors together to make black ink. Donate off-spec ink to schools or give it to another printer rather than paying for disposal.

3. Packaging waste: One of the key concepts of the waste packaging regulations is a reduction in the amount of packaging. The best practice guides to reduce producer responsibility costs associated with packaging are outlined: At design stage of your product identify if packaging is always required? Discuss with your customers the minimum level of packaging acceptable to them, based on this information minimize the amount of packaging used. Review product design in order to identify any areas for waste/packaging reductions like: Is packaging always required? Is the current amount of packaging required? Review how many layers of packaging are needed to meet the required functionality of your product. Review how many raw materials associated with the packaging? Is your product designed to facilitate segregation, disassembly, recovery, reuse and recycling of the associated packaging by your customer or end user? Where appropriate use returnable packaging rather than cardboard or plastic wrapping, Use reusable, returnable containers instead of one use disposal containers, and use bulk containers instead of portable containers.

C. Effluent discharge

The best practice effluent reduction techniques [5] are recommended to minimise / reduce effluent generated on-site:

Prevent or minimise wash down by covering inkwells and applying an anti-drying adhesive to rollers. Dry scrape as much ink as possible before washing. Use high-pressure jet washers for cleaning; they generally use less water than hand-held brushes or low-pressure sprays. Water may then be filtered through a filter pad for re-use. Use dip tanks for water-based screen cleaning; screens can be left to soak in the tanks and materials are used for relatively long periods until exhausted. (The use of organic solvents in dip tanks is not recommended because of the risk of fire).Rinse plates by using multiple counter-current rinse tanks. Install a re-circulation unit to recover wash-up solvent for re-use. A closed loop system with a solvent-recovery unit or a suitable settlement tank may be used. In some cases, ask the supplier to deliver black ink with 10% reduced water content. Wastewater may be added to black ink with no effect on the colour quality of the ink (run trials to determine if suitable). Examples of other practices for effluent management include: Recover silver from photo processing waste. Silver is a valuable natural resource of finite supply, it has monetary value as a recovered commodity, and its release into the environment is strictly regulated. Use less hazardous alternatives for cleaning e.g. water-based cleaner should be used instead of solvent when suitable.

D. Solvent usage

The following examples of best practice solvent management techniques are suggested to reduce solvent use [7]:

Sl.no	Techniques	Description
1	Substitution	1. Consider a switchover from solvent-based ink to a water-based, vegetable oil-based or UV curing ink. The solvent content of water-based inks is approximately 10% - 15%, and UV ink is solvent-free. This particular feature of UV ink is regarded as one of its leading benefits. In addition, less solvent is used for wash-ups of UV inks due to their non-drying properties while on the press. 2. Reduced solvent or solvent-free adhesives are also available e.g. water-based or PU (Polyurethane) glue.
2	Dispensing	1. Promote the use of squeezy bottles to dispense chemicals. These concentrate on the area being applied to and so less chemical is used, less solvent evaporates and waste chemical is reduced. 2. Use plunger cans to moisten cloth wipes to minimise evaporation of solvents. 3. Ensure containers / tanks of solvent are painted in light, reflective colours to minimise heating and evaporation. 4. Examine machinery, valves, pumps, etc. regularly to make sure that bolts are tight and that there are no obvious leaks. 5. Consider machine closures of areas of solvent evaporation. 6. Reduced solvent or solvent-free adhesives are also available e.g. water-based or PU (Polyurethane) glue. 7. Use protective films to prevent solvent ink drying out. 8. Always close containers which have their cap removed. 9. Use an ink stock controller to manage the amount of ink / solvent usage and reduce the risk of over-use. 10.Use a computerised ink mixing system to reduce the risk of overestimating quantities required.
3	Cleaning	1. Pour solvent over equipment and then wipe clean with a rag. Solvent collected in drip pans under the equipment becomes waste solvent which can be reused. Use one container of solvent for each colour printing unit, solvents can then be reused without contaminating the inks. Used solvent can be reused in cleaning most ink from rollers and blankets, with only a small amount of fresh solvent needed for the final clean-up. In some cases, used solvents having one particular ink colour can be used to make up the solvent content of new inks of the same colour. 2. Ensure that the lid of a cleaning tank is closed to reduce solvent emissions. This could be achieved by fitting a spring/ valve that would slowly close the lid. This would eliminate the need for employees to close the lid which can be overlooked. 3.Reduce the size of cloth wipes used on-site for more efficient use and to reduce solvent use.
4	Screen cleaning	1. Use a dry cloth to clean excess ink off the screen before using solvent. 2.Reduce solvent evaporation by storing solvent-wet cloths between use in a re-sealable container 3.Use spray bottles to dispense solvent onto screens for cleaning 4. Clean screens promptly, as soon as print run is finished. If ink dries on the screen, cleaning is more difficult, hence more solvent would be required. 5. Instead of a hand-held brush which can be inefficient, use a pumped brush or high-pressure spray to clean screens.
5	Training	Write procedures for each process that involves the handling or use of solvents, to emphasise ways of

		minimising solvent loss through splashing, over use, poor housekeeping, etc.

E. Emissions to atmosphere

The control of VOCs emissions from printing facilities is important. This section provides information on the air abatement technologies available to treat VOC laden air from the printing and packaging sectors. For companies, which are required to operate within the conditions of an integrated pollution license issued by the Environmental Protection Agency, the requirements of the solvents directive will be incorporated. The control of the air pollutant emissions from an industry can be achieved by prevention and minimising the pollutant generation i.e. using alternatives to solvent based paints and installation of control equipment.

CONCLUSION

In this paper, we review the literature on lean and clean efficient production methodologies which are highly positive in their findings, resulting in strong evidence that lean has in fact a positive contribution in the improvement of the environmental performance according to environmental protection agency standards. The paper described the severe environmental issues facing by the printing and packaging companies which pollute air, water and land.

We believe that this paper can serve a good foundation for printing and packaging industries that, how to reduce and minimize waste at production level by following some of the best organizational practical techniques. The techniques can be applied to medium to large scale sectors according their company standards and environmental legal requirements act policies.

The lean and clean methodological developments and applications practiced in VOC involved companies like textiles, printing, plastics, paints etc. are promising areas for future studies.

REFERENCES

Chahal, V.: "*An Advance Lean Production System in Industry to Improve Flexibility and Quality In manufacturing By Implementation Of FMS & Green Manufacturing*". International Journal of Emerging Technology and Advanced Engineering, Certified Journal, Volume 2, Issue 12, December 2012.

Wang, H., Sezen, M. B.: "*Lean and Green Production Development*".School of Innovation, Design and Engineering, November 2011-diva-portal.org.

Hunt C B and Auster E R (1990), "*Proactive Environmental Management: Avoiding the Toxic Trap*", Sloan Management Review, Vol. 31, No. 2, pp. 7-18.

Unep publication, Government strategies and policies for cleaner production, 1994

www.envirocentre.ie

www.epa.gov/lean/toolkit/connstep.org

www.epa.ie/technical guidance and advice/solvent regulations/

http://www.slideshare.net/shraddhakurdekar/packaging- ppt-17317595

http://www.slideshare.net/dhisim69y/the-fundamentals-about-the- printing-process?qid=245c49c8-67ac-45dc-b263-

Ketchen.J.D.J., Hult, G.T.M, 2007, Bridging organizational theory and SCM: The case of best value supply chains, Journal of Operations management 25 (2), pp.573-580

Corresponding Author

K. Rajesh*

Assistant Professor

E-Mail – rajs005@gmail.com