

Role of Environmental Pollution and Waste Management in Ensuring Business Sustainability Through Innovation

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The population of the world is increasing at the rate of 1, 40,000 per day. There is an increasing need felt by all to get more out of resources and every inch of land, and energy on the planet. This has contributed enormously to the pressure on the environment and resources on earth, and has resulted into environmental pollution, increasing waste generation, social tensions and economic pressures, on an increasing scale. The problem of environmental pollution and waste management has led to the global warming with its deleterious impact on the humanity as such. BS has become the cornerstone of the corporate philosophy, all across the universe. The essential ingredients of BS are planet (ecology), social equity (people), and economy (profit), which is also known as a Triple P approach. The corporate world has already galvanized itself into an action, whereby environmental pollution along with waste management, become key parameters in long term survival and growth of the companies. Besides, governments and the United Nations have enacted the necessary policies and legislations in order to ensure the well being of the mankind.

Concept of Nested BS

Business Sustainability (BS)

BS can be defined as the capacity of a business enterprise to continue to operate successfully, i.e. to generate sufficient and appropriate economic activity to meet stakeholders' requirements *on an ongoing basis*. BS ensures prevention of environmental pollution, social equity and harmony, increase in top line and bottom line. A nested concept of BS is

shown in Figure No.1, whereby an all encompassing

Figure No. 1: Concept of Sustainability: Nested Concept

component is environment. The second component is about people, which shows people dependence on environment. The economic component is dependent on society and environment. Ultimately, a person (employee) depends on all three. This new concept is required to be factored in by the corporate entities while formulating the strategies towards ensuring BS.

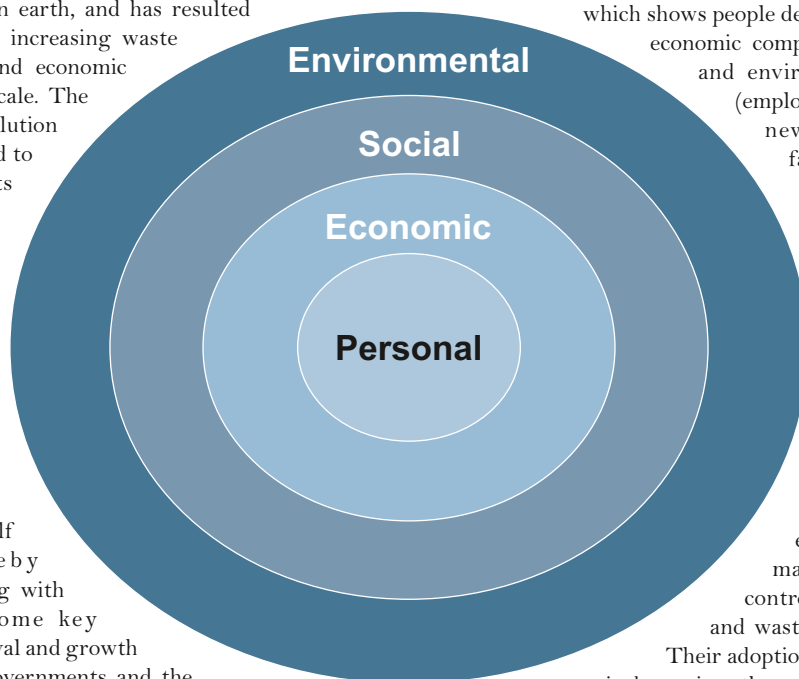
Tools for BS

There are various tools which are of enormous help in ensuring BS. These tools by themselves are innovative in nature, and have proved to be immensely useful in increasing the effectiveness of risk management strategies towards controlling environmental pollution and waste management, in ensuring BS.

Their adoption is only going to increase as BS is becoming the cornerstone of the policies and strategies in all the organizations.

Eco-innovation

Eco-innovation, is a superset of eco-product innovation, eco-process innovation and green manufacturing. Eco-innovation is the development of products and processes that contribute to sustainable development, applying the commercial application of knowledge to elicit direct or indirect ecological improvement. Eco-innovation is linked with



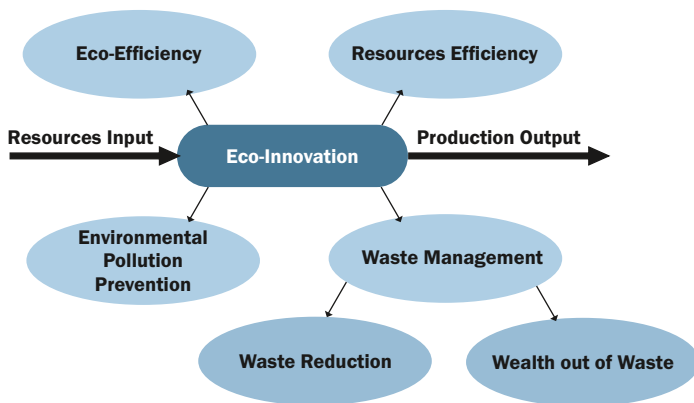


Figure No. 2 : Role of Eco-Innovation in Environmental Pollution Control and Waste Management

environment sustainable technologies, eco-design, eco-efficiency, and sustainable design. As per United Nations Environmental Protocol, eco-innovation provides a win-win solution to improving BS as it starts at the company strategy level and extends its influence even over the entire supply chain management. As can be seen in Figure No. 2, eco-innovation results in eco-efficiency (management philosophy whose goal is to minimize ecological harm while optimizing the efficiency of the company's production processes) as well as resources efficiency. It also accounts for the environmental pollution control and waste management in a holistic manner. This waste management comprises of waste reduction as well as creation of wealth out of waste (WoW). Companies such as 3M, have a deliberate policy to prevent the environmental pollution at the source of manufacturing (Pollution Precaution Pays program) and a pro-active policy of elimination of waste at source itself.

Lean Six Sigma (LSS)

LSS is a methodology that relies on a collaborative team effort to improve performance by systematically removing waste, combining lean manufacturing/lean enterprise and Six Sigma to eliminate the seven kinds of waste (muda): as seen in Figure No. 3. LSS is popular for its methodical approach to streamlining both manufacturing and service processes by eliminating waste while continuing to deliver value to customers. Companies such as 3M, Abbott, Chevron, Textron, BAE systems, and many others have aggressively implemented LSS, and gained enormously. In case of 3M, this is one of the cornerstone of their manufacturing policy. This has helped it not only in elimination waste at source at manufacturing stage itself, but has also proved to be instrumental in virtual elimination of defect occurrence during manufacturing.

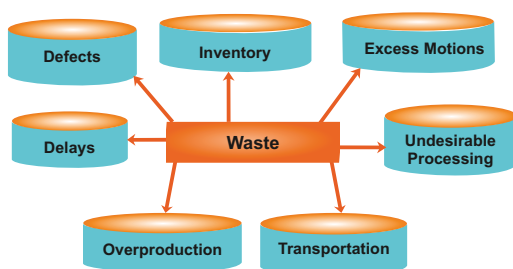


Figure No.3: Types of Waste

10 Ways of Minimising Waste

There are 10 ways of minimising these wastes as articulated by Jonathan Scott. These are as under:

Design Thinking of the Product for Resources Optimisation.

Design thinking is a methodology used by designers to solve complex problems, and find desirable solutions for customers. Design is a process oriented activity. It is in a state of a continuum. It incorporates the function, unique differentiating features, ruggedness, and caters for cost and financial profit. Design thinking also factors in technology and art. Function and financial profit have been supplemented with material recovery and reduced complexity in order to eliminate waste. One of the solutions to have an optimum design for minimum environmental impact and waste is eco-design. Eco-design focuses on actions aimed at environmental improvement of products during initial design phase through functional enhancement, selection of material with lower impact, application of alternate processes, improvement of transportation and use, and minimisation of impact during the end treatment stage. This has led the companies to come out with integrated

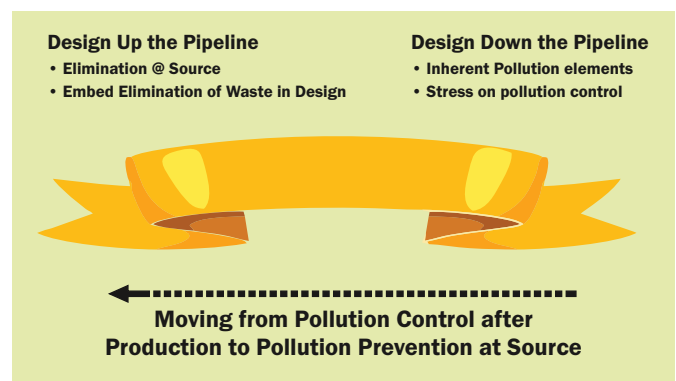


Figure No. 4: Concept of Pollution Control and Elimination of Waste at Source

product policy and life cycle sustainability analysis. Impact table of this environmental impact is prepared products wise (Zbicinski I. Stavenuiter J. Kozłowska B. and Coevering H.⁺ (2006)). After comparing this impact, the raw materials and resources which cause minimum environmental impact, while retaining the desired functional features, are chosen and product is designed accordingly. This can be factored in the design of the manufacturing process itself, wherein there is a paradigm shift from pollution control at end of the pipeline to at the beginning of the pipeline at the source itself that is to at the manufacturing stage itself. The same can be conceptually seen in Figure No.4.

Primarily this is achieved through eco-innovation.

Mapping the Waste Elimination Process

It is always, purposeful to identify practices which lead to generation of waste. The following will be covered in this:

- o Raw materials (including the amounts of whatever is needed to collect, process, and ship them)

- o Manufacturing processes (including manpower needs, material use, energy use, and waste creation)
- o Packaging requirements (the amount of paper, plastic, styrofoam and other materials being consumed)
- o Transportation needs (the amount of energy used to shift materials from one place to another)
- o Maintenance (the chemicals, energy, and water needed to use, maintain, and/or clean whatever is being produced)
- o Use and disposal methods (a description of how the product is thrown away as well as the costs involved in disposal)

Reduce the Amount of Energy Required to Make the Product and Use Sustainable Energy Sources

Future development crucially depends upon the long term availability of energy in increasing quantity from sources that are dependable, safe and environmentally sound. Today's energy sources which are mostly non-renewable in nature have to be substituted with renewable energy sources of energy. Renewable energy is sustainable in that it has virtually ZERO environmental pollution and is sustainable in long term, in that it does not diminish, like solar power or wind energy or tidal power. Renewable energy is the energy of the future.

Use Newer and Cleaner Technologies Whenever Possible

Use newer and cleaner technologies such as waterless washing, which does away with release of pollutants to the environment. The use of environmentally sustainable technologies supports sustainable economic growth, benefiting business, industry and the environment. This leads to sustainable economic growth by reducing and cleaning up environmental pollution, cutting down on the use of energy and other material resources, and increasingly by preventing pollution and waste through cleaner production and recycling. The focus here is on increasingly cleaner production and pollution prevention. This approach is characteristic of the shift from a traditional purely profit-oriented model, to an environmentally sustainable model.

Use Sustainable Remanufactured, Recycled, or Scrap Materials to Manufacture Products

This is the closed loop practice. This allows original raw materials, energy and efforts involved in the manufacture of a product to be recaptured and used again. Recycling is the process of converting waste materials into reusable objects to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, energy usage, air pollution (from incineration) and water pollution (from land-filling) by decreasing the need for "conventional" waste disposal and lowering greenhouse gas emissions compared to plastic production. There are some ISO standards related to recycling such as ISO-15270:2008 for plastics waste and ISO-14001:2004 for environmental management control of recycling practice. For example, recycling aluminum uses about 95% less energy than refining raw aluminum into finished, usable aluminum and also avoids the environmental pollution due to mining. Remanufacturing is a concept of strategic importance that enables a significant part of the value added to a product during its initial production to be retained, and has the potential of revisiting the business model itself.

Improve Quality Control and Process Monitoring in All Production Processes

There is a trend towards improvement upon quality of production inspections and monitoring accompanied by real time information, so that production problems can be identified and problem of waste and consequent environmental pollution tackled at the earliest. Quality control refers to activities to ensure that produced items are fulfilling the highest possible quality. Most of tools and techniques to control quality are statistical techniques. SPC (Statistical Process Control) is the most popular techniques of quality control. Acceptance sampling together with SPC will result in a better process control and product improvement. It ensures reduction in waste and environmental pollution.

Reduce Packaging Requirements; Use Recyclable Packaging Material, or Find Ways to Eliminate Packaging Altogether.

Less packaging saves money in two ways: the first it reduces production expenses, the second it reduces waste disposal costs. The way the products are getting packaged and shipped, is undergoing a huge transformation.

Energy Efficiency

Energy efficiency means using less energy to perform the same function. Sustainability driven firms have a progressive target for reducing energy consumption. Both of these (elimination of waste at source and energy efficiency) result in reduction of cost as well as emissions, and release of toxic matter (gas, solid and liquid) in the environment. The new technology is adopted and processes are fine-tuned. Sustainable consumption of energy has to be ensured through preservation and preventing over-exploitation of renewable energy resources with their associated environmental impact. This is ensured through different types of curtailment behaviour and efficiency behaviour towards consumption of energy.

Reduce, Recycle, Reuse (R3)

The adoption of philosophy of R3 is another potent innovative practice giving very good dividends. The companies are using the philosophy of R3 in order to attain zero waste policy, reduce toxic material and plastic, and having accelerated energy efficiency. The most effective way to reduce waste is to not create it in the first place. Making a new product requires a lot of materials and energy. For manufacturing this product, raw materials must be extracted from the earth, and the product must be fabricated then transported to wherever it will be sold. As a result, reduction and reuse are the most effective ways one can save natural resources, protect the environment and save money. That is how reduced and reuse contribute to sustainability. Recycling helps to reduce energy usage, reduce consumption of raw materials, reduce water and air pollution and reduce greenhouse gases. The use of 3R methodology trend is only going to accentuate.

Substitution

We have seen that the environmental impact mapping through-out the life cycle of the product can be done for the raw materials being

used in the manufacture of the products. This will lead us further to substitution, where the company looks for high performing and less expensive, less risky, or less scarce materials or less hazardous materials will be used. That is how aluminum is replacing steel; carbon fiber which is very light and can be used for building quieter, better performing, more efficient, more comfortable and more beautiful cars (Tesla) or airplanes (Boeing's Dreamliner). Companies like Apple and GE have gone through the periodic table element by element, assessing which ones pose the biggest risks for supply, costs, and regulation; from point of view of sustainability (environment, society and economy). A study shows that 9 gram of carbon emission can be saved if the weight of vehicle is saved by 100 kgs. Aluminium and carbon fibers are great examples of this substitution. These companies have developed substitution opportunities for each risky element.

Life Cycle Management and Analysis (LCMA)

LCMA is another innovation tool used during production, for ensuring environmental sustainability and waste management throughout the life cycle of a product. This LCMA approach has been advocated by Ramon Arratia, which results in resource efficiency. The paper alludes to a report produced by Accenture and World Economic Forum in 2012, whereby they have suggested that \$2 Trillion worth of economic output could be at risk by 2020, if global economies fail to respond to shortage of only one resource, iron. Similar is the case with the other natural resources such as water, energy, materials, food, et al. The evolving regulatory frameworks around the world are veering towards rewarding manufacturers of products that are more resource efficient. That is where the advantage of LCMA giving the designers a clear objective to guide the design of their products, focusing on key impacts rather than merely creating 'feel-good' green gimmicks, has been highlighted.

Sustainable by Design

Another innovation tool which is used is for a product, is sustainable by design. The same again is leveraged by 3M, NESTLE, P&G, UNILEVER and others, in a substantial way. In a broad sense, sustainable by design is the practice of creating something, which has a minimal long-term impact on the environment. Sustainable by design aims to consciously produce products and services that reduce the use of non-renewable resources, minimize environmental impact and connect people with the natural environment. Through a clever design, it substitutes less harmful products and processes for conventional ones, in order to respond to the global environmental crisis. Innovation in design, in the context of sustainability, would entail design of products which would lead to reduction in emission of pollutants. It could also be in the form of design for better energy consumption, with reduced carbon footprint.

Responsible Sourcing

Responsible sourcing, also referred to as supply chain responsibility, is a voluntary commitment by companies to take into account social and environmental considerations when managing their relationships with their suppliers. Suppliers adopting practices such as R3, lean six sigma, elimination of waste, et al; are preferred by companies as a part of responsible sourcing on a global basis. This trend of responsible sourcing is being adopted by all progressive companies. Companies such as P&G, Nestle, Unilever, 3M and others are adopting this practice

of responsible sourcing, which helps in ensuring BS.

Use of Non-Conventional Energy Sources (NCES)/ Renewable Energy Sources (RES)

The fossil fuels have a big inherent drawback of a large carbon footprint, apart from environmental pollution. That is where use of NCESs or RESs such as solar energy, hydrogen cell, wind energy, tidal power, geothermal power, et al; are making rapid strides. RES capture their energy from existing flows of energy, from on-going natural processes, such as sunshine, wind, flowing water, biological processes, and geothermal heat flows. What is more, these are getting incentivised by the governments. This green energy should be tapped by the business. The answer clearly lies in exploring and development of renewable energy sources. As per the International Energy Agency (IEA), renewable electricity expanded at its fastest rate to date (130 GW) in 2014 and accounted for more than 45% of net additions to world capacity in the power sector. Renewable generation costs continued to decline in many parts of the world. In non-conventional energy resources, renewable share of energy generation was 22% in 2013, and is slated to rise to 26% by 2020.

Lean Thinking

Lean thinking is concerned with analyzing whether or not the customer is willing to pay extra for a portion of the process and whether or not the process is critical to the entire product or service delivery. Lean thinking is an innovative way of dealing with the problems in manufacturing as well as supply chain which have a harmful impact on planet, people and profit. Research has shown that lean thinking is one of the most transformative approaches which is cost effective, enduring and powerful, particularly towards ensuring socio-environmental transformation. It removes wasted resources as well as wasted activities. It thus enables reduce waste of non-renewable resources, thereby having a healthy impact on business economics of the company. The cornerstone of lean thinking is value in a wider sense, and not merely profit in a narrow sense. The main emphasis of Lean Thinking is cutting out unnecessary and wasteful steps in the creation of products or services

Wealth out of Waste (WoW) or Woe to Wealth

From ZERO waste concept, the firms are now migrating to the concept of 'Wealth out of Waste' or 'Woe to Wealth'. A case in example is ITC. The WoW policy by ITC is embedded into its sustainability drive, impacting Triple P. This was launched in the year 2007, for the paperboard and specialty papers division. This is through reuse of excess white paper in various stages of pulp dilution in new fiber lines as well as paper machines, effluent utilisation for cooling tower and reuse of back water for floor cleaning in paper machine areas. The specific water intake has been progressively brought down. That is how wealth is created from waste. Composting of waste into a manure, conversion of waste into art such as craft as seen in the creation of a Rock Garden at Chandigarh by New Chand. Conversion of fruit and crops waste such as bagasse into bio-energy, are some of stellar examples whereby, wealth is created out of waste and also the environmental pollution is prevented. Human waste is a harbinger of great risk to human safety and life. That is where Bill Gates, has invested into innovative solutions, whereby the human pooch could be converted into a potable water. Anirudh Sharma, MIT graduate and innovator in India has come up with a way to harvest

black smoke—the kind you see billowing out of chimneys and from car mufflers and repurpose it into a printer ink. Daan Roosegaarde, the Dutch artist, has built a model plant which converts polluted air into jewelry. A Chinese succeeded in making a construction brick out of the smog, which is enveloping cities such as Beijing, Delhi, Los Angeles, in a worrisome way. Delhi and NCR region suffers from the same every winter season. These examples of WoW, could be emulated effectively everywhere.

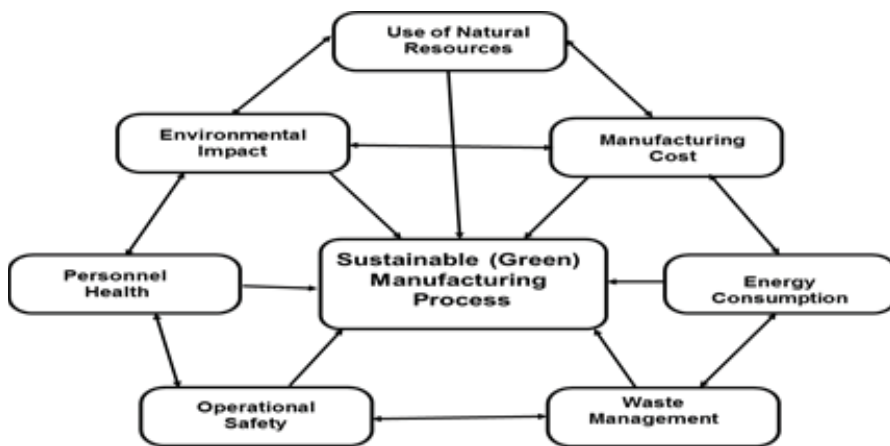


Figure No. 5: Green Manufacturing, (Source: Haapala K., Camelio J., Zhao F. and Sutherland J. (2011). A Review of Engineering Research in Sustainable Manufacturing, Transactions of the ASME

Green Manufacturing

Let us arrive at the concept of green manufacturing. One of the major factor responsible for the degradation of the environment and associated waste, is the generation of the toxic gases such as CO₂, and others, and also the solid waste. This implies a sustainable manufacturing process whereby all the aspects such as use of natural resources (optimization), manufacturing cost (minimisation), energy consumption (minimisation), waste management (optimisation), operational safety (maximisation), personal health (maximisation) and environmental impact (optimisation) are catered for. The manufacturing companies, irrespective of the country of their origin, strive for attainment of this objective. These seven dimensions form the essentials of a green manufacturing process. This will call for the evaluation of the performance of manufacturing environment. That is where sound practices and the audit will play a major role. Green manufacturing will help the mankind in optimising use of natural resources through innovative policies such as reduce, recycle, reuse, substitute, etc; arrest environmental pollution, spur green innovation, reduce costs and promote people health and safety, and provide enormous business opportunities.

Optimisation of Use Natural Resources

The natural resources are always limited, and the rate of their depletion is witnessing a disturbing trend. There is a dire necessity to

use these natural resources optimally. Eco-innovation, LSS and sustainable design will play an important role in ensuring this. Cost audit will have to cover this.

Optimising of Manufacturing Cost

The manufacturing cost needs to be kept down. That is where the tools of BS such as eco-design, LSS and sustainable design will play a natural play. The affordability increases once the manufacturing cost is down, benefitting the consumer as well as the manufacturer. Cost audit will have to cater for this.

Minimisation of Energy Consumption

Energy sources are rapidly depleting, besides creating unnecessary environmental pollution and waste. The energy, both during manufacturing as well as its use, needs to be minimized. That is where eco-design, LSS, LCMA, use of renewable energy sources, energy audit, will play a major role. This will not only minimize cost but will also reduce environmental pollution.

Waste Management

This is getting an increasing attention and will get increasingly critical in nature. The eco-innovation, LCMA, WoW policy will play an increasing role in ensuring sound management practices. Audit of processes and materials will be required in achieving this goal.

Personal Safety

Personal safety is of utmost importance. Eco-innovation as well as LCMA will play a great role in ensuring this personal safety. Safety audit will also have to be carried out.

Operational Safety

This has to be ensured at all costs. Eco-design, LSS, LCMA will play an increasing role in ensuring operational safety. This has to be ensured through safety audit as well.

Environmental Pollution

This is the most crucial factor in ensuring BS. Eco-innovation, use of renewable energy sources, environmental audit will have to address this extremely important issue diligently.

Conclusion

The BS of an organisation as well as the sustainability of the planet as such will critically depend upon the environmental pollution control and waste management practices, which are vital for the mankind as such. Innovation alongwith the sound risk management strategies will be required, which is found in the BS tools. A lot of research is ongoing in this vital area, as it affects the whole planet. Technology, innovation, green manufacturing, eco-innovation, and judicious use of BS tools will play a key role in ensuring effective and efficient environmental pollution control and waste management.

**Maj. Gen. (retd.) T. M. Mhasale retired as Cdr Technical Group, EME, Indian Army. He is an Independent Director in the NBCC Board and is an IOD Masterclass Instructor.*