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RESEARCH ARTICLE

INTEGRATING ENVIRONMENTAL MANAGEMENT AND INDUSTRIAL ECOLOGY: APPROACHES, TOOLS, AND MODELS FOR SUSTAINABLE DEVELOPMENT

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Abstract

The environment encompasses all living and non-living factors influencing an organism, essential for the existence and health of life on Earth. Environmental science and engineering address the interactions between human systems and natural systems, emphasizing the need for sustainable practices to mitigate environmental degradation caused by human activities. This paper explores two primary approaches for environmental protection: Environmental Management and Industrial Ecology. Environmental Management involves strategies like resource optimization, sustainable development, and disaster risk reduction, employing models such as terminal control and pollution prevention. Industrial Ecology focuses on creating industrial ecosystems that mimic natural processes, aiming to minimize waste and optimize resource use. Tools supporting these approaches include Life Cycle Assessment and Design for Environment, which assess and reduce the environmental impacts of products and processes throughout their lifecycle. By integrating these methods, we can enhance environmental protection, improve resource efficiency, and promote sustainable industrial practices.

Introduction:-

All the living and non-living factors affecting an organism and ultimately determining its form and survival are known as Environment.

The environment is an evergreen subject, it plays an important role in healthy living and the existence of life on planet earth. Earth is a home for different living species and we all are dependent on the environment for food, air, water, and other needs.

Our life support systems entirely rely on the well-being of every organism living on planet earth. This is why a lot has been written and spoken about the protection and conservation of the environment. There are even high-value courses dedicated to the study of the environment. A typical example is an environmental science.

Environmental science is a field that deals with the study of the interaction between human systems and natural systems. Natural systems involve the earth itself and life. Human systems are primarily the populations of the earth.

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Environmental science and engineering provide an integrated and interdisciplinary approach to the study of environmental problems using knowledge of environmental concepts and ecology.

Humans are a part of the natural environment. Unfortunately, we have not yet learnt to moderate our activities in such a way as to help the environment. Human activities often lead to degradation of the environment.

Big business gave a lot of things to the people but they are also impacting to the environments. So, that's why the environmental related studies came to the existence.

Environment protection is an important perspective in the current scenario. Environmental stress is becoming severe day by day. Degradation of environment poses a serious threat to humanity.

Different approaches are used to assure environmental protection among them environmental management and industrial ecology

Environments management means to monitor the organizations activities and wastage to make sure that will not impact on the environments and human health.

While industrial ecology is an environmental concept developed by researchers to improve environmental management.

This paper givers an overview about these two approaches and models and tools based on them.

Importance of the environment:
Environment plays an important role in healthy living and the existence of life on planet earth. Earth is a home for different living species and we all are dependent on the environment for food, air, water, and other needs.

For healthy living:
To have a healthy life one needs fresh air (free of pollution), clean water supply and tidy surroundings. If air and water are polluted and surroundings are filthy, then we are prone to fatal health disorders. So we need to safeguard the environment in terms of pollution and disposal of garbage.

Better breath:
All living things breathe air for survival. The air mostly composes of nitrogen, oxygen, carbon dioxide and other gases. Of them, oxygen is the key for the body as it helps in the generation of energy from the food consumed with the help of mitochondria. So fresh air is an important component in the importance of the environment which has to be kept pollution free.

Better water:
Water comprises nearly 80% of total body mass. It is the medium for all the reaction and physiological processes in the body. If the very water is contaminated by filth or toxins or even disease-causing microbes like bacteria, then that water is a great risk to drink.

Better rainfall:
Rainfall is one of the steps of the water cycle on the earth. Without rainfall, there will be no water on the earth (other than sea water which is unfit to drink). This rainfall depends on trees and green vegetation around to shower as the clouds need to be cooled to form droplets. The presence of plants, trees and greenery is essential in the environment for rainfall, fresh air and water.

Better soil:
Soil is the other components of the environment. The soil is useful for the growth of plants which are again a source of food to the animals around. This soil top layer is suitable for plant growth and seed germination. Further, it is a great natural resource for many medicines, metals, chemicals, etc. So, we need to conserve soil for a better environment.

Human activities: Impacts of industry on the Environment
We all know that environment in simple terms means “The surroundings or conditions in which persons, animals, or plants lives or operates”. There is a direct relationship between environment and economic development. Economic development without environmental considerations can cause serious environmental damage in turn impairing the quality of life of present and future generations.

Environmental impacts are changes in the natural or built environment, resulting directly from an activity, that can have adverse effects on the air, land, water, fish, and wildlife or the inhabitants of the ecosystem. Pollution, contamination, or destruction that occurs as a consequence of an action, that can have short-term or long-term ramifications is considered an environmental impact. Most adverse environmental impacts also have a direct link to public health and quality of life issues.

Industrialisation has the potential to help achieve a variety of social objectives, at the same time, industrial processes can have negative environmental impacts.

Industrial processes play a major role in the degradation of the global environment. In industrialised countries, environmental regulation and new technologies are reducing the environmental impact per unit produced, but industrial activities and growing demand are still putting pressures on the environment and the natural resource base. In developing countries, a double environmental effect is occurring: old environmental problems, such as deforestation and soil degradation, remain largely unsolved. At the same time, new problems linked to industrialisation are emerging, such as rising greenhouse gas emissions, air and water pollution, growing volumes of waste, desertification and chemicals pollution.

Any business or developmental activity has a substantial impact on the environment.
*The manufacture of products involves extracting raw materials from the environment and processing them to produce saleable items. As a result of the production process, various forms of waste (solid, liquid and gaseous) enter the environment.
*The activities surrounding the manufacturing process, such as maintenance of plant and infrastructure and the packaging and transport of goods, all have environmental impacts.
*In addition, the products that are produced will eventually be disposed of and enter the environment as waste.
*The provision of services also results in a significant environmental impact. Service companies use various products and also energy to deliver their services, both of which result in waste entering the environment.The provision of services also entails resource exploitation whilst rendering environment unstable.

Environmental science and engineering scientific methods: Environmental protection
Healthy environmental systems not only improve natural systems, but also human wellbeing-based public health systems. Furthermore, applying and developing environmental engineering techniques and knowledge to solve environmental issues such as pollution, and public health issues such as hazardous risk prevention, is crucial. Accordingly, environmental engineering approaches to solutions are fundamental to maintaining healthy environmental systems; and to reducing public health hazards, such as contamination-control, -treatment, and -prevention (e.g., water, air, soil), for hazard exposure reduction.

Environmental engineering studies investigate, analyze, and predict with suitable environmental models, how exposure to hazardous materials occurs in various environments. In doing so, environmental engineering studies contribute to solving environmental challenges by producing valuable analytical insights that engage environmental management; and workable engineering solutions to reduce the negative impacts of human activities on the environment and contribute to the protection of our environment.

Environmental protection refers to any activity to maintain or restore the quality of environmental media through preventing the emission of pollutants or reducing the presence of polluting substances in environmental media. It may consist of:
- ❖ Changes in characteristics of goods and services.
- ❖ Changes in consumption patterns.
- ❖ Changes in production techniques.
- ❖ Treatment or disposal of residuals in separate environmental protection facilities,
- ❖ Recycling.

Prevention of degradation of the landscape and ecosystems.
Different approaches are used to assure environmental protection:

Environment Management
Environment Management is an attempt to control human impact on and interaction with the environment in order to preserve natural resources. It primarily stresses on finding solution to practical problems that people face in cohabitation with nature, resource exploitation, and waste production.

Environmental management focuses on the improvement of human welfare for present and future generation. It implies not only a mere management of environment but it is essentially the management of various activities with intolerable constraints imposed by the environment itself and with full consideration of ecological factors.

Environmental management is closely linked with issues regarding sustainable economic growth, ensuring fair and equitable distribution of resources, and conserving natural resources for future generations.

Environmental management is a response to human actions considering the increasing seriousness and significance of today's disastrous human impact on natural ecosystems.

Importance of Environmental Management
Effective Utilization of Resources:
Resources are limited, if we don't use them properly, they will get exhausted very soon. For appropriate and reasonable use of resources, environment management is necessary. It is our basic responsibly to create an accurate coordination and equilibrium between our needs and procedure of environment.

For sustainable development:
Environmental management is required for development without destruction or overuse of natural resources and to reduce pollution and degradation of nature. Considering the welfare of future generations, proper decisions regarding use of environment are necessary.

To decide the limiting line between environment and development:
Environmental Management is essential to draw a line of limit for development and environment. For E.g. If our development needs to lead to global warming or depletion of the ozone layer, then we must not use the materials, and modify our way of development. We may adopt the policy of afforestation.

For economic need and value:
Environmental Management is required to give new directions to our economic needs and values, at the same time to maintain clean environment.

To reduce disasters:
Environmental Management reduces the risk of disasters like flooding, forest fire,earthquakes, desertification, transport accidents, Global warming, etc. We need to explore the link between environmental system and disasters and also the synergies between man-made and natural disasters.

Environmental management Models :
According to their principles environmental models can be divided into 3:

- **Traditional environmental management based on terminal control:**

Terminal control, also known as terminal treatment, means before the terminal of the production process or the waste discharge into the nature, take a series of physical, chemical or biological measures to reduce the total amount emissions into the environment.

- **Environmental management model based on pollution prevention:**

Pollution prevention (P2) is a strategy for reducing the amount of waste created and released into the environment, particularly by industrial facilities, agriculture, or consumers. Many large corporations view P2 as a method of improving the efficiency and profitability of production processes by waste reduction and technology advancements.

It includes:
- ✓ Source reduction
- ✓ Waste reduction
- ✓ Circular economy
- ✓ Pollution Prevention

- Environmental planning and management of pollution prevention model implementation process

Environmental management systems
As a pollution prevention approach Environmental System Management (ESM) is considered as a powerful tool for managing the adverse impacts of activities of an organization on the environment aspects it is generally regarded as proactive tool of corporate environmental management.

An environmental management system Serves as a process, to improve environmental performance and information mainly "design, pollution control and waste minimization, training, reporting to top management, and the setting of goals.it also provides a systematic way of managing an organization's environmental affairs

It Is the aspect of the organization's overall management structure that addresses immediate and long-term impacts of its products, services and processes on the environment. environmental management system assists with planning, controlling and monitoring policies in an organization.

The system follows a repeating cycle (see figure 1).

The organization first commits to an environmental policy, then uses its policy as a basis for establishing a plan, which sets objectives and targets for improving environmental performance. The next step is implementation. After that, the organization evaluates its environmental performance to see whether the objectives and targets are being met. If targets are not being met, corrective action is taken. The results of this evaluation are then reviewed by top management to see if the environmental management system is working. Management revisits the environmental policy and sets new targets in a revised plan. The company then implements the revised plan. The cycle repeats, and continuous improvement occurs.

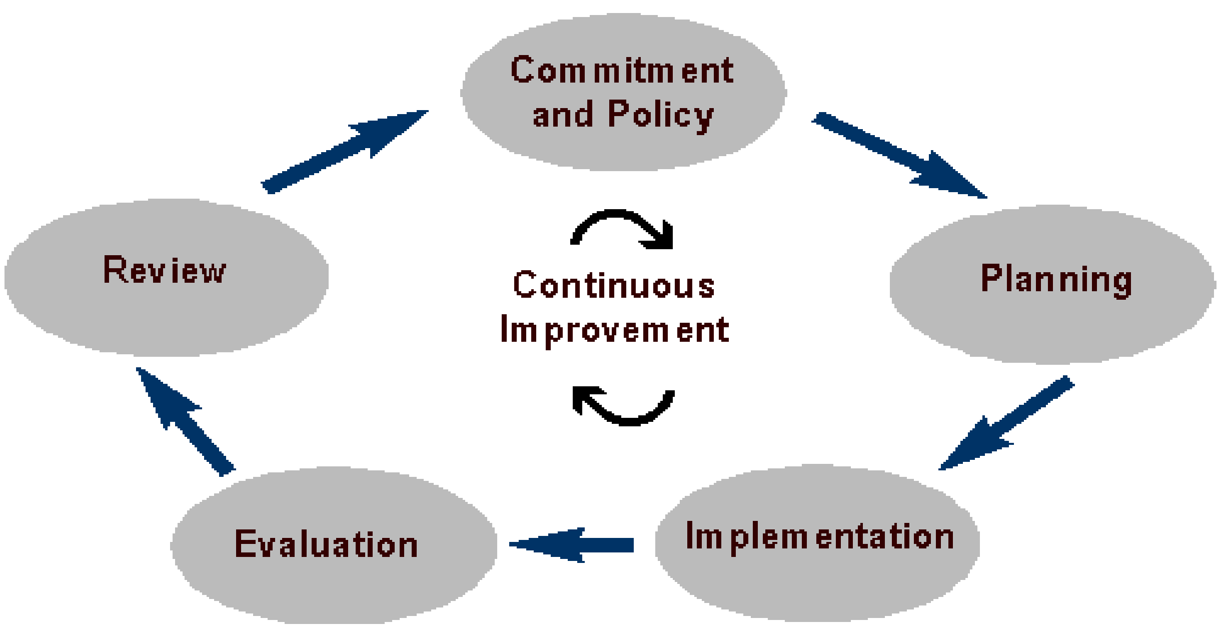


Figure 1: The continuous improvement cycle.

The 3 main types of Environmental Management System: Acorn BS8555, EMAS and ISO14001.

- Acorn - BS 8555 British standards – A phased EMS implementation that is more small business friendly.
- EMAS (Eco Management Audit Scheme) - Voluntary EU legislation available for free.
- ISO14001 – International Organisation for Standardisation’s system - certification for environmental management.

The most commonly used framework for an environmental management system is the one developed by the International Organization for Standardization (ISO) for the ISO 14001 standard.

The five main stages of an environmental management system, as defined by the ISO 14001 standard are described below:

Commitment and Policy –
Top management commits to environmental improvement and establishes the organization's environmental policy. The policy is the foundation of the environmental management system.

Planning –
An organization first identifies environmental aspects of its operations. Environmental aspects are those items, such as air pollutants or hazardous waste, that can have negative impacts on people and/or the environment. An organization then determines which aspects are significant by choosing criteria considered most important by the organization. For example, an organization may choose worker health and safety, environmental compliance, and cost as its criteria. Once significant environmental aspects are determined, an organization sets objectives and targets. An objective is an overall environmental goal (e.g., minimize use of chemical X). A target is a detailed, quantified requirement that arises from the objectives. The final part of the planning stage is devising an action plan for meeting the targets. This includes designating responsibilities, establishing a schedule, and outlining clearly defined steps to meet the targets.

Implementation –
A organization follows through with the action plan using the necessary resources (human, financial, etc.). An important component is employee training and awareness for all employees. Other steps in the implementation stage include documentation, following operating procedures, and setting up internal and external communication lines.

Evaluation –
A company monitors its operations to evaluate whether targets are being met. If not, the company takes corrective action.

Review –
Top management reviews the results of the evaluation to see if the EMS is working. Management determines whether the original environmental policy is consistent with the organization's values. The plan is then revised to optimize the effectiveness of the EMS. The review stage creates a loop of continuous improvement for a company.

Benefits to implementing an Environmental management system:
An Environmental management system helps:
Reduce waste:
Every organization can reduce waste from the smallest of companies with a recycling program to larger companies who minimize waste through design innovations.

Maximize resources:
Maximizing is closely aligned with waste reduction. When a business can get more than one use out of their raw material this has multiple benefits.

Waste reduction – The more you can use out of one source the less you will throw away. Decreasing waste transport costs and transport emissions and resulting in less landfill.

Increased Efficiency – Ordering 1 product instead of multiples can save time in the procurement process, reduce delivery costs and storage space needed.

Circular Economy
The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended.

In practice, it implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible. These can be productively used again and again, thereby creating further value.

This is a departure from the traditional, linear economic model, which is based on a take-make-consume-throw away pattern. This model relies on large quantities of cheap, easily accessible materials and energy.

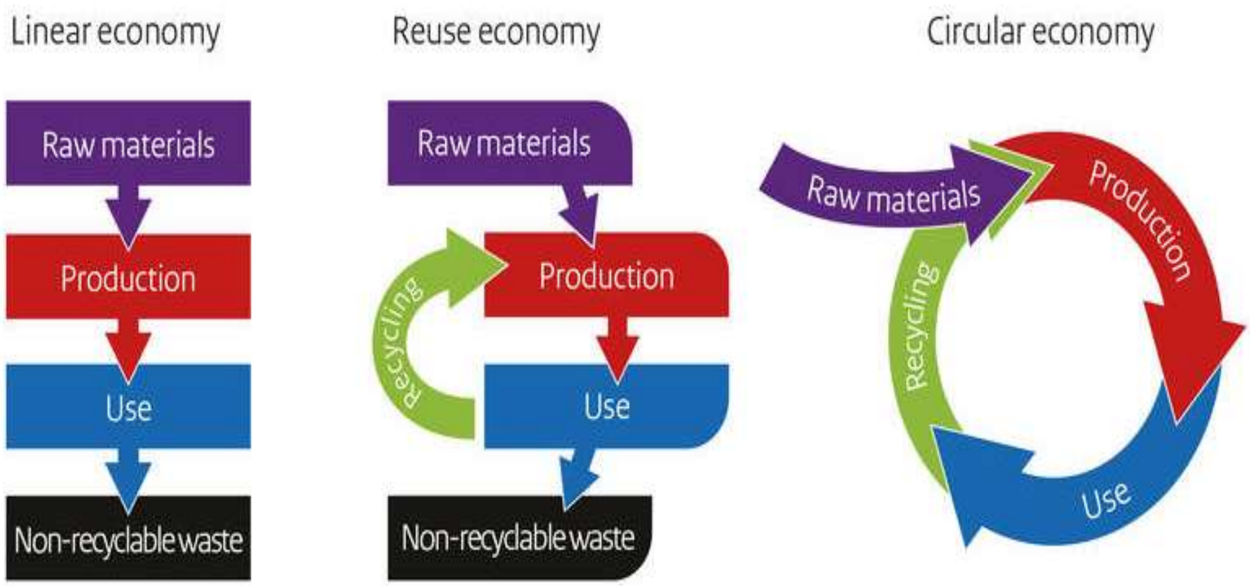


Fig 2:- Principles of linear economy, reuse economy and circular economy.

In a circular economy, manufacturers design products to be reusable. For example, electrical devices are designed in such a way that they are easier to repair. Products and raw materials are also reused as much as possible. For example, by recycling plastic into pellets for making new plastic products. In a circular economy we treat our surroundings responsibly. For example, by preventing litter on streets or in the natural environment.

The Principles of The Circular Economy:
Energy and Resources Are Gold:
At its core, a circular economy model has the intention of designing out waste. In fact, a circular economy is based on the idea that there is no such thing as waste. In order to achieve this, products are designed to last (good quality materials are used) and optimized for a cycle of disassembly and reuse that will make it easier to handle and transform or renew them.

Following Nature's Cycles and Designs:
The circular economy model makes a distinction between technical and biological cycles. Consumption happens only in biological cycles, where biologically-based materials (such as food, linen or cork) are designed to feed back into the system through processes like anaerobic digestion and composting.

These cycles regenerate living systems, such as soil or the oceans, which provide renewable resources for the economy. By their turn, technical cycles recover and restore products (e.g. washing machines), components (e.g. motherboards), and materials (e.g. limestone) through strategies like reuse, repair, remanufacture or recycling.

All in With Renewable Energies:
The last principle of a circular economy has to do with the fact that the energy required to fuel this cycle should be renewable by nature.

Why a circular economy is important?
As well as creating new opportunities for growth, a more circular economy will:
- ✓ Reduce waste
- ✓ Prevent pollution because it uses renewable energy that in the long run is less polluting than fossil fuels.
- ✓ Drive greater resource productivity
- ✓ Help reduce the environmental impacts of our production and consumption.
- ✓ Reduce pressures on the environment: a circular economy would significantly reduce greenhouse gas (GHG) emissions through better waste management and reduced use of resources (such as energy, water, land and materials) in manufacturing, with positive impacts on the climate. Large-scale reuse of raw

Measures such as waste prevention, eco-design and re-use could save companies money while also reducing total annual greenhouse gas emissions.

Consumers will also be provided with more durable and innovative products that will increase the quality of life and save them money in the long term.

Industrial Ecology:
Industrial ecology is an environmental concept developed by researchers to improve environmental management. Industrial ecology attempts to induce balance and cooperation between industrial processes and environmental sustainability, such that neither violates the other. This approach, thus, aims to develop industrial processes that minimize material waste and pollutants in materials, according to the cradle-to-cradle concept.

Industrial ecology arises from the perception that human economic activity is causing unacceptable changes in basic environmental support systems. As applied to manufacturing, this systems-oriented concept suggests that industrial design and manufacturing processes are not performed in isolation from their surroundings, but rather are influenced by them and, in turn, influence them.

In industrial ecology, economic systems are viewed not in isolation from their surrounding systems, but in concert with them. Industrial ecology seeks to optimize the total materials cycle from virgin material to finished material to component, to product, to waste products, and to ultimate disposal. It is a field of study that focuses on the stages of the production processes of goods and services from a point of view of nature, trying to mimic a natural system by conserving and reusing resources.

Industrial ecology conceptualizes industry as a man-made ecosystem that operates in a similar way to natural ecosystems, where the waste or by product of one process is used as an input into another process. Industrial ecology interacts with natural ecosystems and attempts to move from a linear to cyclical or closed loop system. Like natural ecosystems, industrial ecology is in a continual state of flux.

Main Features:
Industrial processes, from material extraction through to product disposal, have an adverse impact upon the environment. Industrial ecology aims to reduce environmental stress caused by industry whilst encouraging innovation, resource efficiency and sustained growth. Industrial ecology acknowledges that industry will continue operate and expand however, it supports industry that is environmentally conscious and has less burden upon the planet. It views industrial sites as part of a wider ecology rather than an external, solitary entity.

Within the industrial ecology concept, industry interacts with nature and utilizes the wastes and by products of other industries as inputs into its own processes. Industrial ecology ranges from purely industrial ecosystems to purely natural ecosystems with a range of hybrid industrial/natural ecosystems in between. Covering both industrial management and technology, industrial ecology encompasses other sustainability concepts and tools such as material flows analysis; environmentally sound technologies; design for disassembly; and dematerialization.

The principles of industrial ecology as defined by Tibbs (1992) are:
Create industrial ecosystems –
close the loop; view waste as a resource; create partnerships with other industries to trade by-products which are used as inputs to other processes.

Balance industrial inputs and outputs to natural levels –
Manage the environmental-industrial interface; increase knowledge of ecosystem behavior, recovery time and capacity; increase knowledge of how and when industry can interact with natural ecosystems and the limitations.

Dematerialization of industrial output –
Use fewer virgin materials and energy by becoming more resource efficient; reuse materials or substituting more environmentally friendly materials; do more with less.

Improve the efficiency of industrial processes –
Redesign products, processes, equipment; reuse materials to conserve resources.

Energy use –
Incorporate energy supply within the industrial ecology; use alternative sources of energy that have less or no impact upon the environment.

Align policies with the industrial ecology concept –
Incorporate environment and economics into organizational, national and international policies; internalize the externalities; use economic instruments to encourage a move towards industrial ecology; use a more appropriate discount rate; use a more comprehensive index to measure a nation's wealth rather than GNP.

Benefits of industrial ecology
The benefits of industrial ecology include:
- ✓ Cost savings (materials purchasing, licensing fees, waste disposal fees, etc);
- ✓ Conserving natural resources by Minimizing energy and materials usage.
- ✓ Income generation through selling waste or by products.

Tools to Support Industrial Ecology:
- ✓ Design for Environment and Life Cycle Design.
- ✓ Industrial Metabolism.
- ✓ Life-cycle Assessment.
- ✓ Cleaner Production & Pollution Prevention.
- ✓ Energy Optimization.
- ✓ Dematerialization: Product-life extension.

Design for Environment and Life Cycle Design:
The design of products shapes the environmental performance of the goods and services that are produced to satisfy our individual and societal needs. Environmental concerns need to be more effectively addressed in the design process to reduce the environmental impacts associated with a product over its life cycle. Life Cycle Design, Design for Environment, and other similar initiatives based on the product life cycle are being developed to systematically incorporate these environmental concerns into the design process.

Life Cycle Design (LCD) is a systems-oriented approach for designing more ecologically and economically sustainable product systems. Coupling the product development cycle used in business with a product's physical life cycle, LCD integrates environmental requirements into each design stage so total impacts caused by the product system can be reduced.

Design for Environment (DfE) is another design strategy that can be used to design products with reduced environmental burden. It uses a series of matrices in an attempt to develop and then incorporate environmental requirements into the design process.

Design for Environment is based on the product life cycle framework and focuses on integrating environmental issues into products and process design.

Design for Environment and Life cycle design seek to minimize the environmental consequences of each product system component: product, process, distribution and management.

Methodology:-

The Needs Analysis

A typical design project begins with needs analysis. During this phase, the purpose and scope of the project is defined, and customer needs and market demand are clearly identified.The system boundaries (the scope of the project) can cover the full life cycle system, a partial system, or individual stages of the life cycle. Understandably, the more comprehensive the system of study, the greater the number of opportunities identified for reducing environmental impact.

Design Requirements

Once the projects needs have been established, they are used in formulating design criteria. This step is often considered to be the most important phase in the design process. Incorporating key environmental requirements into the design process as early as possible can prevent the need for costly, time-consuming adjustments later.

A primary objective of LCD is to incorporate environmental requirements into the design criteria along with the more traditional considerations of performance, cost, cultural, and legal requirements.

Residuals	**Ecological Health**	**Human Health and Safety**	
Amount & Type: • Renewable • Nonrenewable	Type: • Solid waste • Air emissions • Waterborne	Stressors: • Physical • Biological • Chemical	Exposure Routes: • Inhalation, contact, ingestion • Duration & frequency
Resource Base: • Location • Local vs. Other • Availability • Quality • Management • Restoration practices	Environmental Fate: • Containment • Bioaccumulation • Degradability • Mobility/transport • Ecological impacts • Human health impacts	Impact Categories: • Diversity • Sustainability • Resilience • System structure • System function	Population at Risk: • Workers • Users • Community
Character: • Virgin • Reused/recycled • Reusable/ recyclable	Characterization: • Constituents • Amount • Concentration • Toxicity • Hazardous content • Radioactivity	Scale: • Local • Regional • Global	Toxic Character: • Acute effects • Chronic effects • Morbidity/mortality
Impacts From: Extraction and Use • Material/energy use • Residuals • Ecosystem health • Human health			Nuisance Effects : • Noise • Odors • Visibility

Table 1:- Issues to consider when developing environmental requirements.

Design Strategies

Once the criteria have been defined, the design team can then use design strategies to meet these requirements. Multiple strategies often must be synthesized in order to translate these requirements into solutions.

A wide range of strategies are available for satisfying environmental requirements, including product system life extension, material life extension, material selection, and efficient distribution.

Design Evaluation

Finally, it is critical that the design is evaluated and analyzed throughout the design process. Tools for design evaluation range from Life cycle assessment to single-focus environmental metrics. In each case, design solutions are evaluated with respect to a full spectrum of criteria, which includes cost and performance.

Life Cycle Assessment:

Life Cycle Assessment (LCA) is used as a tool to assess the environmental impacts of a product, process or activity throughout its life cycle.

Life Cycle Assessment is a process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment; to assess the impact of those energy and materials used and releases to the environment; and to identify and evaluate opportunities to affect environmental improvements.

The assessment includes the entire life cycle of the product, process or activity, encompassing, extracting and processing raw materials; manufacturing, transportation and distribution; use, re-use, maintenance; recycling, and final disposal. For each of these steps there will be made an inventory of the use of material and energy and the emissions to the environment. With this inventory an environmental profile will be set up, which makes it possible to identify the weak points in the lifecycle of the system studied. These weak points are the focal points for improving the system from an environmental point of view.

According to the ISO standards there are four main stages of a Life Cycle Assessment are:

Goal and scope definition:

It's important to define a clear goal and scope of study, by identifying the Life Cycle Assessment's purpose and the expected products of the study and determining the boundaries (what is and is not included in the study) and assumptions based upon the goal definition, you choose a functional basis for comparison and you define the required level of detail. You then set a goal which determines the scope, including objective, application and audience. Lastly, you determine whether or not there has to be a critical review of that goal.

Life-cycle inventory:

Identification and quantification of energy and resource use and environmental releases to air, water, and land associated with each stage of production.

Impact analysis:

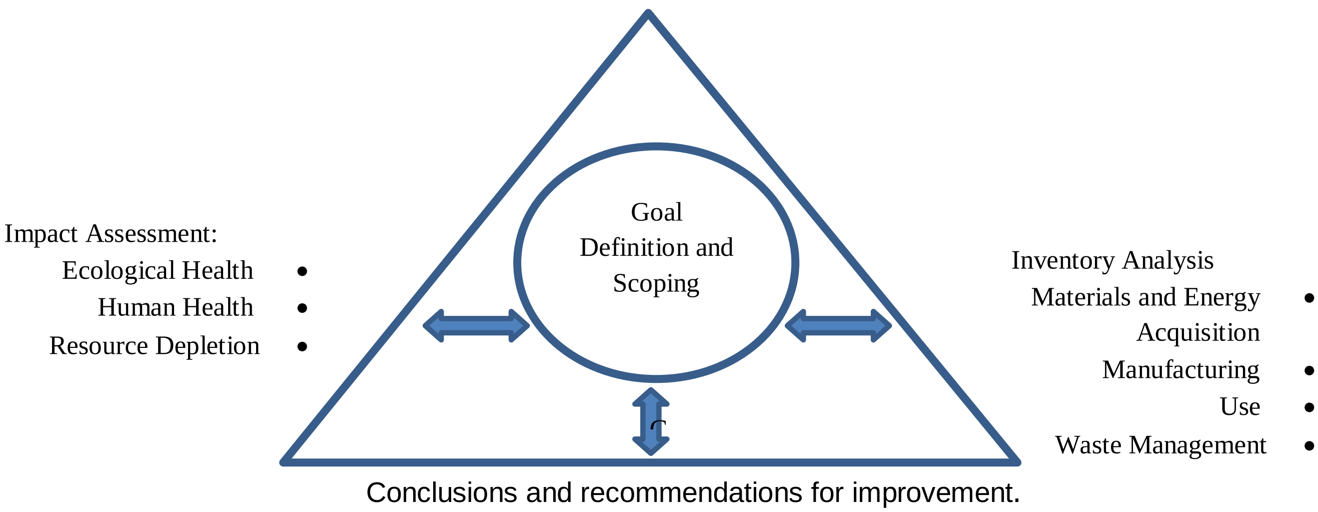
Assessing the impacts on human health and the environment associated with energy and raw material inputs and environmental releases quantified by the inventory, you classify resource use and emissions generated according to their potential impacts and quantify them for a limited number of impact categories, which you may then assess in terms of their relative importance for the goal of the LCA study

Interpretation (Conclusions and Recommendations):-

This is the key output of the life cycle assessment. The results will be analyzed in detail to determine the impact hotspots and the key environmental impact categories. These can then be used to make recommendations for improvement.

Life Cycle Assessment helps decision-makers select the product, process, or technology that results in the least impact to the environment. This information can be used with other factors, such as cost and performance data to find optimal solutions.

Life Cycle Assessment identifies the transfer of environmental impacts from one media to another (for instance: a new process may lower air emissions, but creates more wastewater, etc.) and between different lifecycle stages.



The diagram below illustrates the main lifecycle stages to be considered in Life Cycle Assessment:

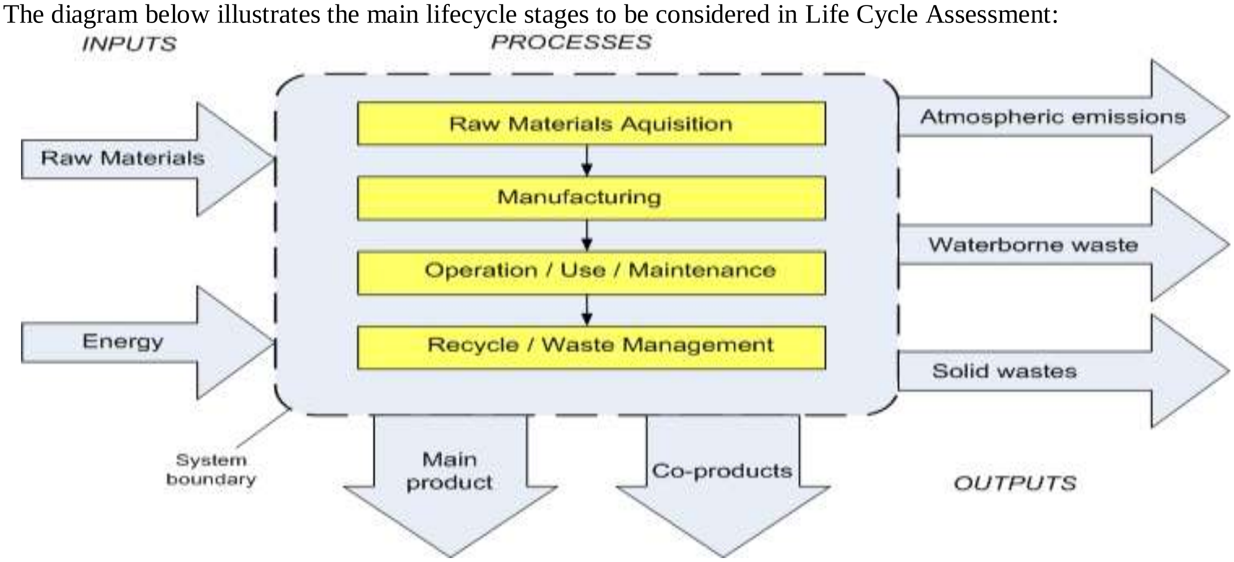


Figure 4:- The main stages and typical inflows and outflows considered in lifecycle assessment.

Why is Life Cycle Assessment Important?

- Lifecycle assessment helps us to make comparisons between different products and services to understand their impact on the environment over the whole of their lifecycle.
- The results of the study provide the manufacturer and material suppliers with information to reduce life cycle impacts of the products.
- It also helps consumers to make informed decisions about the relative environmental benefits of a range of different products.
- It can inform operating, manufacturing and supply chain decisions to move towards more sustainable options.

Conclusion:-

Earth's environment is changing rapidly due to the impacts of increasing population, rapid industrialization, urbanization and extensive use of natural resources. Degradation of ecosystems, threats to biodiversity, environmental pollution, climate change, natural disasters and the degradation of natural resources are major challenges faced by society. Today, we have become increasingly aware of problems arising from environmental negligence; environmental policy will succeed only if it focuses on strategies that address the root causes of environmental problems.

The country is not called developed simply by making big factories, buildings, roads, etc. If physical development, as well as environmental development, will be given importance only then a country can progress. Otherwise, it will remain as a concrete forest. A healthy environment can decide the direction of any country. If anyone's element of the environment is manipulated, its results can be very painful.

The goal of environmental engineering is to ensure that societal development and the use of water, land and air resources are sustainable. This goal is achieved by managing these resources by creating and using different methods and models based on different field of sciences; chemistry, physics, biology, ecology, etc. So that environmental pollution and degradation is minimized.

Resources are limited and willing are unlimited. The environment management helps to control the effective utilization of resources. Environment management creates a bridge between actual needs and willingness.

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