Theory behind Sustainable Development

- Economics and trade theory
- Human rights and social theory
- Environmental theory and impact assessment methods

Economic factors for sustainable development based on trade and growth theory but including qualitative growth instead of unlimited quantitative growth.

Human Rights and Social Theory

- The right to life
- The right to liberty and freedom of movement
- The right to equality before the law
- The right to presumption of innocence until proven guilty
- The right to appeal a conviction
- The right to be recognized as a person before the law
- The right to privacy and protection of privacy by law
- Freedom of thought, morality, and religion
- Freedom of opinion and expression
- Freedom of assembly and association.

Environmental Theory and Impact Assessment Methods

- Dealing with a sustainable environment means following an approach 'from the cradle to the grave,' a life-cycle perspective of goods. Because many goods are processed only at selected life cycle stages, companies focus more on optimizing a facility than on goods or services.
- Research and applied research try to provide us with environmental information for decision-making.There are two main areas in research to develop a theory for environmental damage assessment:

⊕ The first **indicators** have been developed to estimate impacts on an **inventory** base and

⊕ The second scientific impact assessment tools, like **life cycle assessment (LCA)** and **ecological key figures** (**EKF**), assess the impact of the inventories and thereby give a holistic assessment of the damage.

(2019,22) Corporate Social Responsibilities (CSR)/ Ethical Production of Textiles

- Social responsibility is one of the three components/basic principles and concepts of sustainability (US EPA, 2008e).
- Companies manufacturing cotton textiles must consider corporate social responsibility (CSR) as part of doing business.
- Definitions of CSR vary based on several factors, including industry sector, organizational structure, location, and relative business importance.
- Common elements of CSR are:

a. A reliance on meeting or exceeding the letter and spirit of legal, ethical, commercial, and other business requirements; and
b. A focus on the impact of a company's operations, products, and services on people, communities, and the environment.

Some Key Corporate Social Responsibility Issues

- Human rights and worker safety in the workplace
- Marketplace Integrity
- Environment impacts

Life Cycle (2021,22)

The **Life Cycle** is the consecutive and interlinked stages of a product or service system, from the extraction of natural resources to the final disposal. The life cycle of a product is shown in Figure 2. Products can be evaluated through each stage of their life cycles, namely:

Key Corporate Social Responsibility (CSR) Issues in the Textile Industry:

Labor Rights and Fair Wages:
Ensuring safe working conditions, fair pay, and no child or forced labor.

Environmental Impact:
Reducing pollution, chemical waste, and carbon emissions throughout the production process.

Sustainable Sourcing:
Using eco-friendly raw materials and ensuring supply chains follow ethical practices.

Health and Safety:
Providing proper safety equipment, training, and a clean working environment.

Community Engagement:
Supporting local communities through education, healthcare, and development programs.

Transparency and Accountability:
Open reporting on sourcing, labor practices, and environmental impact to build consumer trust.

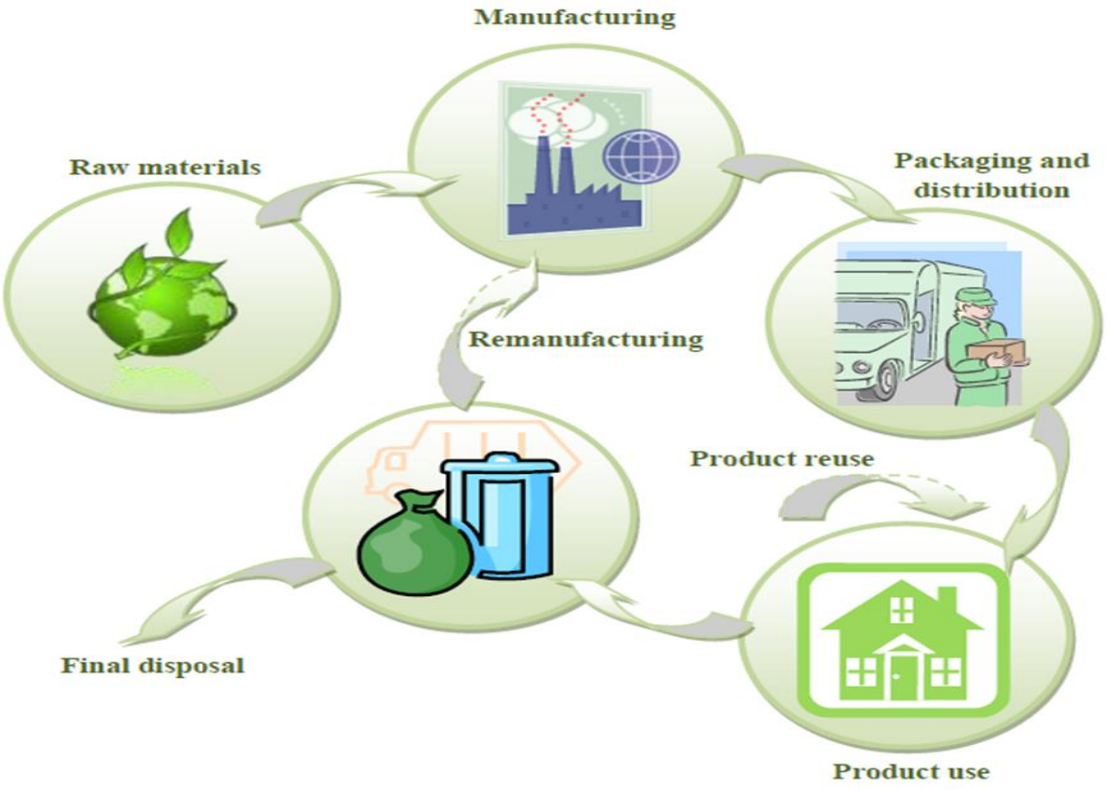


Figure 2: Life cycle of a product (2021,22)

- Extraction or acquisition of raw materials (mainly cotton fibers)
- Manufacturing and processing (making of yarn, fabric, preparation, and dyeing)
- Packaging (paper, plastic, etc.)
- Transportation and distribution of products
- Use and reuse
- Recycling
- Disposal

For each stage, inputs of materials are identified, and the energy required is assessed; outputs of valuable products and waste emissions are measured. Optimal points for improvement are identified, and eco-efficiency is estimated.

Life Cycle Assessment (LCA) (2019,20,21)

LCA is a tool for assessing the environmental impact of a product, process, or service during its entire life cycle from the "cradle to grave." It may be used, for example, for product development and improvement, strategic planning, public policymaking, and marketing. The LCA tool is used for finding the hot spots in the life cycle to make the best decisions on minimizing the environmental burdens of the product, process, or service. It is also used for comparisons between different products regarding environmental impact. The main development of this method took place in the 1990s, and it has been standardized in ISO standards no. 14040 to 14043. Although it has been standardized, methodological problems remain, some of which will be discussed in this report, focusing on textiles.

Thus, LCA, also known as life cycle analysis, Eco-balance, or cradle-to-grave analysis, involves a systematic scientific approach to examine the environmental impacts of the entire life cycle of a product or service.

It is not simply the quality of the product or the amount of waste that ends up in a landfill or an incinerator, but the product's whole life cycle that determines its environmental impact.

LCA is the technique associated with all the stages in the life cycle of a product, from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. LCA is also a way of collecting metrics about whether or not green improvements have been made.

LCA is used for much more than waste minimization; it is also used for estimating CO2 and GHG emissions and is probably the most common way to investigate the flow of energy and water in any process.

The Environmental Management and Audit Scheme (EMAS) are currently used as guidelines and standards for environmental strategies for LCA. The main ecological strategies are.

The Strategy is based on environmental requirements and laws, whereas the company's Strategy is based on observance of environmental laws and other requirements.

Strategy based on preventive actions, when the company concentrates on preventing environmental hazards and risks.

Strategy based on ecological competitiveness by effective use of resources and by making use of the eco-marketing possibilities.

Strategy based on the principles of sustainable development. The company's environmental Strategy pays attention to social justice and the rights of the future generation, in addition to an effective ecological policy.

The strategies listed cover all the important economic, social, and environmental aspects of a designer's Strategy to develop sustainably. Strategy 1 and 4 fall under the social aspect, strategy 2 falls under the environmental aspect, and strategy 3 falls under the economic aspect.

(19,20) Basic Principle/Important Steps/ Components of CLA

LCA is a holistic assessment method concerning life cycle phases and environmental impact categories, thus preventing shifting burdens. The iterative character of LCA, allowing for adjustments as a result of new insights, is described by the arrows back and forth between the four phases in Figure 3. According to the ISO 14040 and 14044 standards, an LCA is carried out in four phases, as shown in Figure 3:

1. **Goal and scope definition:** This includes defining the study's system boundaries and the functional unit (e.g., one day of use for a garment). This quantitative measure of the product's function enables comparisons of different products.

2. **Life cycle inventory analysis** (LCI): where a comprehensive list of relevant inflows and outflows is developed, including emissions to air, water, and soil, as well as the use of resources in the form of energy, water, material, and land area, for each process included in the product's life cycle.

3. **Life cycle impact assessment (LCIA)** relates the inflows and outflows from the LCI to potential environmental impacts via characterization factors. Climate change, acidification, human toxicity, Eco-toxicity, eutrophication, and resource depletion are common impact categories. The selection of impact categories is made based on relevance to the study.

4. **Improvement Analysis**: **Interpretation of results**, which includes drawing conclusions from the outcome of the LCI and LCIA and determining the level of confidence in the final results

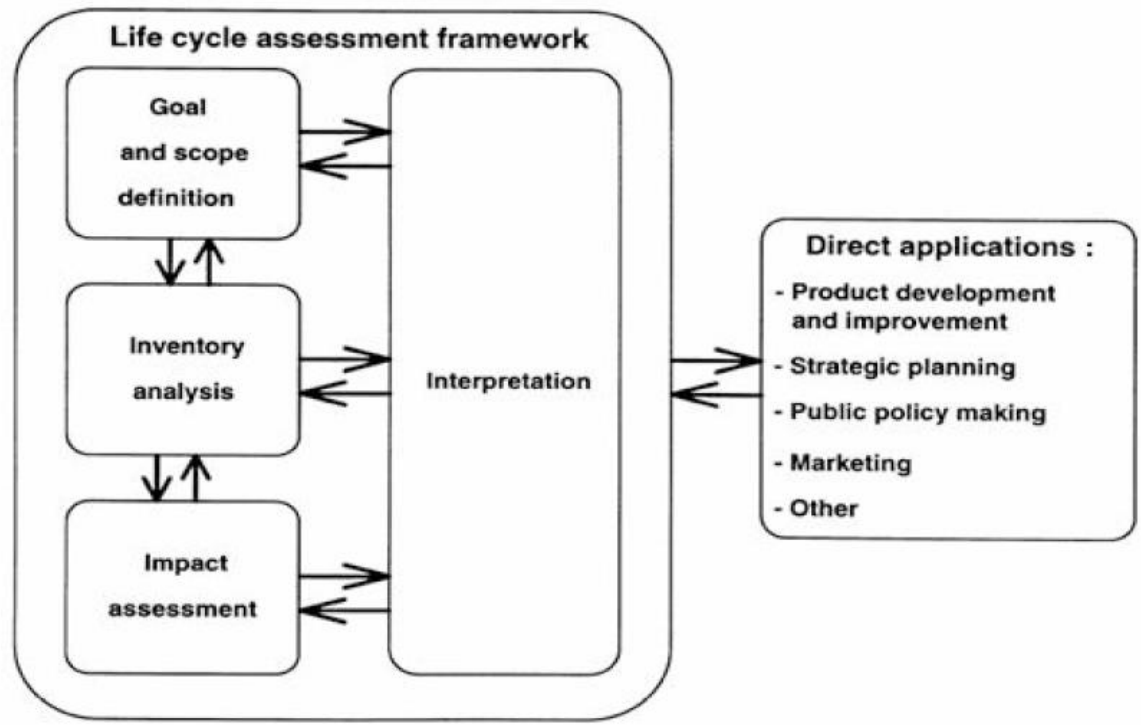


Fig.3: The four phases of an LCA and their interrelations in the LCA framework (2021)

Ecological Key Factors (EKF) (2019,22)

An **Environmental Factor**, **Ecological Factor** or **Eco Factor** is any factors that influence living organisms which include **light, temperature, soil, water, etc**.

These factors may be **biotic** (living) and **abiotic** (non-living).

Abiotic factors include sunlight, water, temperature, air, and soil in which organisms live.

Biotic factors: These are all kinds of interactions between different forms of life. These are plants, animals, microorganisms, etc.

Some of the major Ecological Key Factors that constitute the environment of an organism are as follows:

1. **Climatic Factors.**
2. **Edaphic Factors**
3. **Topographic Factors**
4. **Biotic Factors**

1. Climatic Factors.

Climatic factors include rainfall, humidity, wind, atmospheric gases, temperature, and light.

2. Edaphic Factors

These deal with the structure and composition of soil, its physical and chemical properties and details of related aspects.

3. Topographic Factors

The factors concerned with physical geography of the earth are known as topographic factors. These factors influence vegetation which causes

variation in climate of a geographic region, ultimately give rise to a characteristic microclimate.

4. Biotic Factors

Biotic factors are the most important factors influencing the growth and distribution of plants and animals. Out of all the biotic factors, food supply for animals is the most common factor limiting the growth of animal population either directly through being short of requirements or indirectly through behavioural responses to food shortage.

Ecological Key Factors Model

- The models for ecological key factors are developed for all production sites in the value-added chain of (cotton) textiles.
- They have been evaluated in practical applications for spinning and weaving processes.
- EKF are based on equations for individual processes along the value-added chain, taking into the account main specific settings in production as well as basic environmental impact assessment.

The scope of a theoretical model consequently is to be developed according to the following seven requirements: (2020,21,22)

1. Based on an individual company's production data
2. Discloses specific differences between different processes and technologies

3. Reveals differences in resource management
4. Includes all relevant global environmental impacts
5. Includes a life cycle perspective according to ISO 14040
6. Allows independence of national legislation
7. Allows independence of national costs (wages, energy, etc.).
   - The first three requirements implicate the company's business strategy.

The limit of Eco-Efficiency (2019)

The concept of eco-efficiency was introduced by the World Business Council for Sustainable Development (WBCSD) in the early 1990s.

It is based on the concept of creating more goods and services while using fewer resources and creating less waste and pollution.

Eco-efficiency is a sustainability measure combining environmental and economic performances.

A popular definition of eco-efficiency by WBCSD is 'being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity.

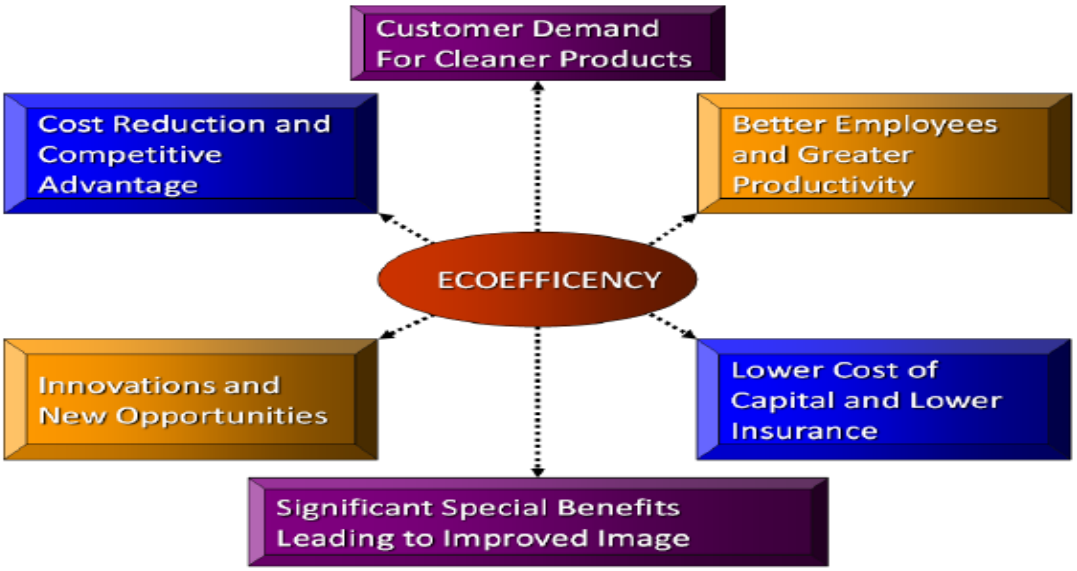


Figure4: Eco-efficiency

Objectives of Eco-efficiency

- To increase product or service values.
- To optimize the usages of resources.
- To reduce environmental impacts

Eco-efficiency: Environmental Cost / Economic Output

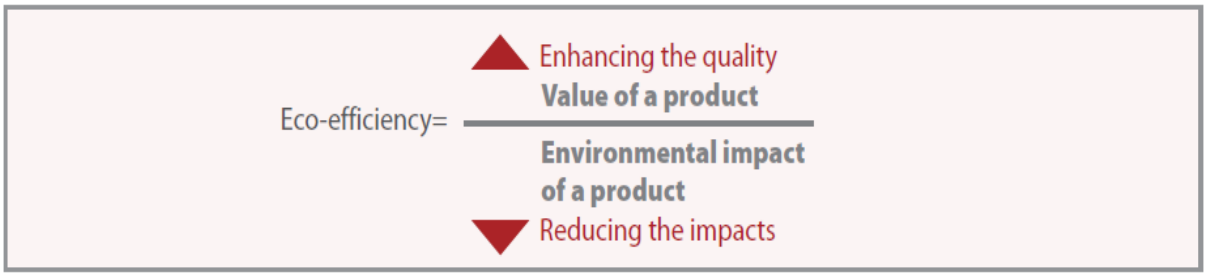
Environmental costs can be:

- Pollution emissions (CO_2 or SO_x emissions, biochemical oxygen demand, etc.)
- Resource-used (energy or water used)
- Cost associated with an environmental burden (traffic congestion costs)

Economic output can be:

- Value added of benefit (GDP per capita)
- Unit of product or service (per km, per m_2)
- Cost associated with an environmental burden (traffic congestion costs)

Eco-efficiency in the business sector



Practical benefits of Eco-efficiency

1. Reducing material intensity of goods and services,
2. Reducing energy intensity of goods and services,
3. Reducing the dispersion of any toxic materials,
4. Enhancing the recyclability of materials,
5. Making the maximum possible utilization of renewable resources,
6. Enhancing the durability (shelf time) of products,.
7. Improving service intensity of goods and services.