UNIVERSITY OF THE AEGEAN
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CHAPTER 4

VALUE CHAIN FOR MINIMIZING WASTE RESOURCES

IN CIRCULAR AGRICULTURE

Chapter 4: Value chain for minimizing waste resources in circular agriculture

This chapter delves into the intricacies of the value chain for minimizing waste resources. It explores the interconnected steps involved in reducing waste generation and maximizing resource efficiency throughout the lifecycle of products and services. Drawing upon insights from sustainable practices and circular economy principles, it examines each stage of the value chain, from resource procurement to end-of-life management, to uncover strategies for minimizing waste and promoting sustainability.Throughout this chapter, the importance of adopting sustainable practices at each stage of the value chain, from responsible sourcing of raw materials to efficient manufacturing processes, eco-friendly packaging solutions and consumer education initiatives, will be highlighted. By understanding the key principles and practices associated with waste reduction, learners will gain valuable insights into how businesses and organizations can contribute to a more sustainable and CA.

4.1 Resource procurement

Resource sourcing is the initial step in the value chain and plays a crucial role in reducing waste and increasing sustainability. Choosing raw materials and inputs from suppliers that prioritize sustainability and environmental responsibility is key to minimizing the overall environmental impact. Companies can opt for renewable, recycled, or responsibly sourced materials, which not only reduce environmental impact but also promote the circular economy.

4.1.1 Renewable and recycled materials

Bioplastics: Produced from renewable sources such as cornstarch, sugarcane and algae, bioplastics are biodegradable and reduce dependence on fossil fuels. Using bioplastics in products or packaging can significantly reduce plastic waste and carbon emissions.

Recycled paper and cardboard: Using recycled paper and cardboard for packaging and other industrial uses reduces demand for new forest resources and waste levels. Recycled paper requires less energy and water than new paper production, contributing to a more sustainable product life cycle.

Recycled metals: Recycled aluminum and steel can be reused in various industries. Recycling these metals requires less energy than extracting and processing new metals.

4.1.2 Responsibly Sourced Materials

FSC Certified Wood: Wood from sustainably managed forests certified by the Forest Stewardship Council (FSC) ensures that forestry practices meet high environmental and social standards. The use of certified wood can mitigate deforestation and protect biodiversity.

Organic Cotton: Cotton grown without the use of pesticides and chemical fertilizers reduces soil and water pollution. In addition, organic certification ensures sustainable farming practices and decent working conditions for workers.

Sustainable Raw Materials for Technology: Minerals such as lithium and cobalt, when mined and processed according to ethical and sustainable practices, can reduce environmental impacts and improve social responsibility in the supply chain of electronic devices.

Adopting these sustainable practices in resource sourcing not only minimizes waste, but also encourages a product life cycle that is regenerative by nature. This contributes to the circular economy, where materials are continuously reused and recycled, minimizing the extraction of new resources and the accumulation of waste.

4.2 Product Design

A crucial aspect of sustainable development is the product design focusing on waste product minimization. This parameter covers the entire lifecycle of the product, from raw material extraction to manufacturing, usage, and end-of-life disposal. A basic aspect is the product design for higher durability and longevity, the ease of disassembly so as products to fulfill the requirements of 3R (reuse, recycling, repair) and the clear labeling to facilitate sorting and recycling. Moreover, the material efficiency is also very important covering the need for optimized use of the materials often using a computer-aided design program (CAD), a lightweighting product resulting to the reduction of energy and transport cost and the incorporation, if possible, of waste materials from other processes into the specific product design. Moreover, the sort of materials is also vital. Sustainable materials may be separated to recycled materials from post-consumer or post-industrial sources, biodegradable or photodegradable materials or edible films, which are friendly to the environment and finally the use of materials from renewable resources, i.e. materials from natural sources. Other factors such as the work with suppliers who follow sustainable practices and can provide certification for materials and the reduction in the number of different materials (minimizing product variety) used to simplify recycling processes are also crucial for product design eco-friendly strategies.

Product design should also cover the aspects of life-cycling thinking. More specifically, the lifecycle assessment and the end-of-life planning are two parameters that influence the product final design. It is necessary to understand and minimize the environmental impact of a product throughout its lifecycle and to design a product having in mind the end-of-life image of it. Moreover, the product design shall consider energy and water efficiency. The production

process from the first to the last step should follow the rules of circular economy reducing the loss of water using it for other applications such as crop irrigation and the minimization of energy loss through the development of eco-friendly industrial processes. Moreover, space efficiency of the products is also an important factor covering the design of products and reducing simultaneously the transportation and storage issues.

Companies should also invest in educating consumers to become more environmentally conscious. Measures in this direction can be the creation of incentives for the return of used products and their recycling as well as clear instructions in the manuals regarding the repair, upgrade and recycling of the products. Companies that are active in the creation of electronic and electrical devices (modular products) that are easily repaired and by extension have a longer life as well as companies that through electronic means, e.g. internet, resell recycled or low-use products are the best examples of sustainability and circular economy

Waste minimization in product design is not only beneficial for the environment but can also be economically advantageous. It reduces costs associated with material waste, enhances brand reputation, and meets increasing consumer demand for sustainable products. By integrating these principles and strategies into the design process, companies can create products that are more sustainable, efficient, and appealing to environmentally conscious consumers. Minimizing waste throughout the entire lifecycle of a product requires a holistic approach, from the initial design phase through to end-of-life disposal.

Takeaways

1.Minimization of Waste: Sustainable product design focuses on minimizing waste throughout the entire lifecycle, from raw material extraction to end-of-life disposal.
2. 3R Concept: The 3R concept (Reuse, Recycling, Repair) is integral to sustainable design, aiming to maximize product longevity and facilitate circular economy practices.
3. Material Efficiency: Optimizing material use through tools like AutoCAD and lightweighting reduces energy and transport costs, promoting efficiency.
4. Material Types: Sustainable materials include recycled materials, biodegradable or photodegradable materials, and those sourced from renewable resources.
5. Lifecycle Thinking: Lifecycle assessment and end-of-life planning are crucial in understanding and reducing environmental impacts across a product's lifecycle.
6. Circular Economy: Principles of the circular economy minimize waste, enhance energy and water efficiency, and optimize space efficiency in product design.
7. Consumer Education: Educating consumers fosters environmentally conscious behaviors, such as product return incentives and clear repair and recycling instructions.
8. Economic Benefits: Waste minimization not only benefits the environment but also reduces costs associated with material waste and enhances brand reputation.

Ideas to consider

1. **Design for Durability and Longevity**:

Focus on creating products that are robust and durable to extend their lifespan and reduce the frequency of replacement.

2. **Ease of Disassembly and Repair**:

Design products that are easy to disassemble for repair, upgrade, or recycling, supporting the principles of the circular economy.

3. **Optimized Material Use**:
Utilize computer-aided design (CAD) software to optimize material use, ensuring products are efficient in both material consumption and performance.

4. **Lightweighting**:
Reduce material weight where possible to decrease energy consumption during manufacturing and transportation, while maintaining product integrity.

5. **Incorporation of Recycled Materials**:
Integrate recycled materials from post-consumer or post-industrial sources into product designs, promoting resource conservation and waste reduction.

6. **Use of Sustainable Materials**:
Explore materials that are biodegradable, photodegradable, or sourced from renewable resources to minimize environmental impact.

7. **Lifecycle Thinking**:
Conduct lifecycle assessments to understand and minimize the environmental footprint of products across their entire lifecycle, from production to disposal.

8. **Efficient Use of Energy and Water**:
Optimize production processes to reduce water usage and energy consumption, utilizing resources more efficiently and minimizing environmental impact.

9. **Space Efficiency in Design**:
Design products that optimize space during transportation and storage, reducing packaging needs and logistical costs.

10. **Collaboration with Sustainable Suppliers**:
Partner with suppliers who adhere to sustainable practices and provide certified materials, ensuring transparency and environmental responsibility throughout the supply chain.

11. **Consumer Education and Engagement**:
Educate consumers about the environmental benefits of products and empower them with information on proper disposal, recycling, and reuse options.

12. **Circular Economy Initiatives**:
Implement circular economy principles such as product take-back programs, remanufacturing, and recycling initiatives to close the loop on product lifecycles.

4.3 Manufacturing Processes

The demand for sustainable development of cities and the use of environmentally friendly manufacturing techniques are necessities these days. The introduction of environmentally friendly processes will significantly reduce waste outputs and the use of energy and water resources by ensuring the creation of products that meet environmentally friendly specifications.

A basic technique for achieving efficient manufacturing processes with a focus on waste reduction is the lean manufacturing which leads to the elimination of waste and the improvement of industrial efficiency. Lean manufacturing is based on specific principles which covers the aspect of the identity value from the consumer's perspective, the mapping of

the value stream, the creation of a harmonized and integrated set of processes in which activities move in a constant stream, a continuous choice of perfection and finally the establishment of a system, where the creation of a new activity is based on the customer's demand as a result of flexibility and communication.

A new circular strategy applied in manufacturing operations to achieve the goals of circular economy is the green-lean-six sigma (GLSS). This strategy is recognized as an emerging way to minimize resource waste flows, to remove systematically the non-added value (NVA) activities, to streamline processes, to control processes through variation reduction and produce products without defects. Other aspects that influence GLSS are the need for material and resource circulation and the environmental conservation in the production and management operations.

Moreover, sustainability and smart automation technologies can be combined and are crucial factors for the manufacturing processes. Smart technologies can increase productivity and simultaneously reduce the environmental impacts so as to follow the Industry 4.0 technology adoption. The implementation of robotic process automation (RPA) is vital for the increase in precision in manufactures and the reduction of human errors and material wastes. Moreover, the utilisation of computer-aided design (CAD) and computer-aided manufacturing (CAM) optimizes designs and manufacturing processes, ensuring efficient use of materials. Finally, the implementation of IoT devices to monitor equipment performance and predict maintenance needs, reduces downtime and waste.

The manufacturing industry has been evolving to reduce its environmental impact by product-oriented and process-oriented optimization. This area focuses on the optimization of the material use and the reduction of waste. Key parameters are the replacement of materials and the use of new ones that produce less waste and are easier to recycle. It is necessary to implement systems to collect, recycle, reuse scrap materials within the production process and to use inventory management systems to reduce material overstocking and waste. Other waste reduction techniques are the closed loop systems where waste materials are captured and reused in the production process. For instance, a sustainable or green manufacturing practice can replace plastics with bioplastics derived from natural sources incorporated in manufacturing cycle as direct raw material substitution.

Manufacturing consumes both renewable and non-renewable materials (e.g. metals, fossil oil-derived materials, and water) as well as significant amounts of energy, resulting in environmental degradation. Manufacturing activities dominate industrial energy consumption. The investment in energy-efficient equipment as a result to more stringent regulations (e.g. emission standards, worker exposure standards, and banned materials) will reduce CO_2 emissions waste treatment, disposal costs and conserve energy, water, and materials.

The adoption of new technologies in manufacturing must be followed by the employee training and engagement. A unique training offer to achieve a multidisciplinary expertise in smart manufacturing is a crucial and inevitable target. Building on novel educational paradigms and recent developments in the area of manufacturing, the main goal of the program is to provide the European industry with outstanding experts willing, able, and trained to bring novel solutions that address relevant societal challenges.

Implementing efficient manufacturing processes is essential for reducing waste generation. By leveraging lean manufacturing, green-lean-six sigma, automation, sustainable materials management, energy efficiency, waste reduction techniques, and employee engagement, companies can significantly minimize waste while enhancing productivity and profitability. This comprehensive approach not only benefits the environment but also leads to a more sustainable and resilient manufacturing operation.

Takeaways

1. **Importance of Sustainable Development**: Sustainable manufacturing is crucial for reducing waste outputs, conserving energy and water resources, and meeting environmentally friendly specifications.
2. **Lean Manufacturing Principles**: Lean manufacturing focuses on eliminating waste and creating efficient processes through principles like value stream mapping, continuous flow, and continuous improvement.
3. **Green-Lean-Six Sigma (GLSS)**: GLSS integrates green practices with lean and Six Sigma methodologies to minimize resource waste, remove non-value-added activities, and control processes for defect-free production.
4. **Smart Automation Technologies**: Adoption of Industry 4.0 technologies, such as robotic process automation (RPA), computer-aided design (CAD), and Internet of Things (IoT), enhances productivity while reducing environmental impacts.
5. **Material Efficiency and Waste Reduction**: Techniques like just-in-time (JIT) inventory management, closed-loop systems, and direct substitution of sustainable materials contribute to minimizing material overstocking and waste.
6. **Energy Efficiency**: Investment in energy-efficient equipment helps in reducing CO_2 emissions, waste treatment costs, and conserving energy, water, and materials.
7. **Employee Training and Engagement**: Successful adoption of new technologies requires multidisciplinary expertise and continuous training to engage employees in sustainable manufacturing practices.

Ideas to consider

1. **Design for Sustainability**: Focus on designing products and processes that prioritize durability, recyclability, and the use of sustainable materials.
2. **Lean Manufacturing Implementation**: Implement lean principles to streamline operations, eliminate waste, and improve efficiency throughout the manufacturing process.
3. **Integration of Green Practices**: Integrate green practices such as GLSS to systematically reduce resource waste and enhance process control.
4. **Adoption of Smart Technologies**: Embrace Industry 4.0 technologies like RPA, CAD, CAM, and IoT to optimize manufacturing processes and reduce environmental impacts.
5. **Waste Management Systems**: Implement closed-loop systems and JIT inventory management to minimize material waste and improve resource efficiency.
6. **Energy and Resource Conservation**: Invest in energy-efficient equipment and practices to reduce energy consumption, CO2 emissions, and waste treatment costs.

7. **Employee Training and Development**: Provide continuous training and foster a culture of sustainability to empower employees with the skills and knowledge to support sustainable manufacturing practices.
8. **Regulatory Compliance and Certification**: Ensure compliance with environmental regulations and seek certifications that validate sustainable manufacturing practices.
9. **Collaboration and Supplier Engagement**: Collaborate with suppliers who follow sustainable practices and prioritize environmental conservation in their operations.
10. **Continuous Improvement**: Foster a culture of continuous improvement to regularly assess and optimize manufacturing processes for sustainability and efficiency.

4.4 Packaging

Packaging plays an important function in the food industry to facilitate products handling, transport, stacking, storage, and distribution. Packaging main role is the protection of foods from the environmental conditions, the avoidance of the transfer of organic or inorganic chemical substances to the product during their contact and the microbiological stabilization of the product.

The design of packaging should follow specific standards, i.e., simplicity, integrated design and right sizing. Packaging should be tailored to fit the product precisely, minimizing excess material. Additionally, it must fulfill multiple roles, such as providing protection, facilitating marketing, and enabling storage. Unnecessary layers should be avoided, and designs should prioritize using the minimal amount of material needed for protection and presentation.

In the pursuit of sustainable packaging solutions, it is essential to use recycled content, biodegradable materials, and renewable resources. Utilizing materials that have been recycled reduces the need for virgin resources, conserving natural materials and lowering the carbon footprint. Selecting biodegradable materials such as paper, cardboard, or bioplastics ensures that packaging will naturally decompose, reducing landfill waste and environmental pollution. Additionally, incorporating renewable resources like bamboo or plant-based plastics promotes sustainability by relying on materials that can be replenished over time.

Reusable packaging is an essential strategy for sustainability, aiming to design packaging that can be reused multiple times. This approach includes creating refillable containers that consumers can refill and reuse, using durable materials and designs that withstand multiple uses, such as glass bottles or sturdy plastic containers. Additionally, implementing systems where customers can return packaging for reuse, like beer kegs or milk bottles, further enhances the reusability of packaging.

Lightweighting is a critical strategy in packaging design aimed at reducing material usage and lowering transportation emissions. This approach involves using thinner materials that maintain strength and protection, thereby minimizing the overall weight of the packaging. Innovative structural design techniques are employed to ensure integrity while using less material, optimizing efficiency without sacrificing performance. Additionally, leveraging advanced materials with high strength-to-weight ratios further enhances the effectiveness of lightweight packaging solutions. By prioritizing lightweighting strategies, businesses can

significantly reduce environmental impact throughout the packaging lifecycle, from production to disposal.

Recyclable packaging aims to facilitate easy recycling processes throughout its lifecycle. This is achieved by designing packaging using a single type of material to simplify recycling efforts, ensuring clear labeling with recycling instructions directly on the packaging, and selecting materials that are widely accepted by local recycling programs. By adhering to these principles, recyclable packaging minimizes waste and promotes the efficient reuse of materials, contributing to environmental sustainability.

Compostable packaging focuses on designing materials that can naturally decompose at the end of their lifecycle. This involves using certified compostable materials that meet industrial or home composting standards, enabling consumers to dispose of packaging in composting facilities. Designs often include features for home compostability, making it accessible for consumers to participate in sustainable waste management practices. Education about proper composting techniques further supports the widespread adoption of compostable packaging solutions, reducing landfill waste and supporting soil health

Innovative packaging solutions explore cutting-edge technologies and materials to enhance sustainability and functionality. These include edible packaging options made from biodegradable materials like seaweed or rice, which offer safe consumption and minimal environmental impact. Water-soluble packaging is utilized for specific applications such as single-use laundry pods, dissolving safely in water to reduce waste. Plantable packaging integrates seeds into biodegradable materials, allowing consumers to plant packaging waste to grow plants, promoting ecological benefits and circularity in packaging practices.

Supply chain optimization strategies aim to reduce packaging waste across the entire supply chain. Bulk shipping practices minimize individual packaging needs by shipping products in larger quantities. Reusable shipping containers are employed for logistics, reducing the demand for single-use packaging materials. Optimized shipping and storage practices enhance efficiency, decreasing the reliance on excessive protective packaging and lowering environmental impact. These approaches collectively improve resource management and contribute to a more sustainable supply chain ecosystem.

Takeaways

1. **Packaging Functions**: Facilitates handling, transport, stacking, storage, and protects food from environmental conditions and chemical transfer.
2. **Design Principles**: Follows simplicity, integrated design, and right sizing to minimize material use and fulfill multiple roles.
3. **Sustainable Materials**: Uses recycled content, biodegradable materials, and renewable resources to reduce environmental impact.
4. **Reusable Packaging**: Focuses on durability and multiple-use containers to minimize waste and support sustainability.
5. **Lightweighting**: Reduces material usage and transportation emissions while maintaining packaging integrity.
6. **Recyclable Packaging**: Simplifies recycling processes with clear labeling and single-material designs to enhance recyclability.

7. **Compostable Packaging**: Designed to decompose naturally in industrial or home composting systems, reducing landfill waste.
8. **Innovative Solutions**: Integrates advanced technologies like edible, water-soluble, and plantable materials to enhance sustainability and functionality.
9. **Supply Chain Optimization**: Reduces packaging waste through bulk shipping, reusable containers, and optimized logistics practices.
10. **Environmental Impact**: Emphasizes waste reduction, resource efficiency, and sustainable practices throughout the packaging lifecycle.

Ideas to consider

1. **Design for Minimal Environmental Impact:** Focus on designing packaging that minimizes environmental impact throughout its lifecycle, from production to disposal. Incorporate principles of simplicity, integrated design, and right sizing to reduce material usage and waste generation.
2. **Utilization of Sustainable Materials:** Emphasize the use of recycled content, biodegradable materials, and renewable resources in packaging design. Opt for materials that have minimal environmental footprint and can be easily recycled or composted at the end of their life.
3. **Promotion of Reusable Packaging:** Implement strategies to promote reusable packaging solutions that can be refilled and reused multiple times. Design durable packaging using materials like glass or sturdy plastics, and establish systems for customers to return packaging for reuse.
4. **Adoption of Lightweighting Strategies:** Prioritize lightweight packaging designs to reduce material consumption and transportation emissions. Utilize advanced materials and innovative structural design techniques to maintain packaging integrity while minimizing weight.
5. **Facilitation of Recycling Processes:** Design packaging that is easily recyclable by using a single type of material and providing clear recycling instructions. Ensure compatibility with local recycling programs to promote efficient material reuse and waste reduction.
6. **Development of Compostable Packaging:** Explore materials certified for industrial or home composting to enable environmentally friendly disposal options. Educate consumers on proper composting techniques to encourage widespread adoption of compostable packaging solutions.
7. **Innovation in Packaging Technologies:** Invest in research and development of innovative packaging technologies, such as edible packaging and water-soluble materials, to enhance sustainability and functionality. Integrate seeds into biodegradable materials for plantable packaging options that promote circularity.
8. **Optimization of Supply Chain Practices:** Implement supply chain optimization strategies like bulk shipping and reusable shipping containers to minimize packaging waste and reduce environmental impact. Optimize shipping and storage practices to enhance efficiency and sustainability across the supply chain.
9. **Compliance with Regulatory Standards:** Stay informed about local and international regulations concerning packaging materials, recycling standards, and environmental impact

assessments. Ensure compliance to mitigate legal risks and uphold responsible packaging practices.

10. **Continuous Improvement and Industry Collaboration:** Foster a culture of continuous improvement within the organization to innovate and refine sustainable packaging solutions. Collaborate with industry peers, research institutions, and organizations to share best practices and drive advancements in sustainable packaging practices

4.5. Distribution and Logistics

Distribution and logistics are crucial steps in the value chain, directly affecting energy consumption and carbon emissions associated with the movement of goods. Optimizing transportation and distribution networks can contribute significantly to reducing waste and improving overall efficiency.

4.5.1 Shipping Consolidation Strategies

Route Planning: Implementing advanced route optimization software can reduce the distance vehicles travel, thereby decreasing fuel consumption and greenhouse gas emissions. Companies can use algorithms to calculate the most efficient routes, considering variables such as traffic and road conditions.

Load Consolidation: Grouping shipments to maximize the use of space in vehicles reduces the number of trips required. This approach not only decreases CO2 emissions but also lowers transportation costs.

Regional Logistics Hubs: Establishing regional distribution centers can reduce transportation distances between final origin and destination points, thereby optimizing last-mile logistics. This is especially important in urban areas, where traffic congestion can be significant.

4.5.2 Efficient Modes of Transportation

Intermodal Transportation: The combined use of different modes of transportation, such as trains and trucks, can optimize transportation time and costs while reducing carbon emissions. Trains, for example, are more energy efficient for transporting goods over long distances than trucks.

Low Environmental Impact Vehicles: The adoption of electric or hybrid vehicles for distribution can significantly reduce CO2 emissions. In addition, the use of technologies such as hydrogen engines can be a long-term solution for sustainable logistics.

Sea and River Transport: For international or high volume shipments, sea transport may be a more sustainable option than air transport due to the greater energy efficiency of ships. The use of barges for transport along rivers can also reduce the load on road networks.

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4.6 Consumer Use

Sustainable consumption has become an increasingly important topic of debate in the world over the last decade. Sustainable production and consumption of goods and services is a major focus of both the public and private sectors. Sustainable consumption is defined as conscious and sustainable consumption behaviour that aims to meet individual needs by acquiring, using or disposing of relevant goods or services without harming the environment and social well-being (Geiger Fischer and Schrader, 2018).

While the EU is making great efforts to become a more sustainable union, this is not enough to be achieved by government initiatives alone but must be accompanied by a change in consumption patterns. Societies are not homogeneous across countries, with social (different cultures, values, goals) and economic environments influencing consumers in different ways, so the relevance of sustainable consumption is not the same across countries (Pacita Project). For this reason, governments and businesses are undertaking a variety of citizen awareness, information projects and initiatives on sustainability.

Consumption is increasing due to the availability of sustainability information to support purchasing decisions. 87% of consumers are concerned about the social and environmental impacts of the goods they purchase (Shao, 2016). In addition, consumers are becoming more demanding, requiring more and more information not only about the composition of the product, but also about the supply chain and production processes. The authors argue that both government and organisations must take responsibility for providing consumers with information on the sustainability of a product (Shao, Taisch, & Mier, 2017).

This suggests that consumers are concerned about sustainable consumption and that the role of the company in this context is linked to the purchase of the product. Recognising the importance of a sustainability strategy and the importance of increasing the availability of information to consumers, a strong emphasis must be placed on educating and informing consumers about the sustainability of goods and services.

Consumer awareness has a significant impact on the promotion of environmentally friendly goods on the market. According to Urbaitytė K., (2020), eco-labelling is one of the methods by which consumers are made aware of the environmental impact of products. The

European Union's labelling provides credible information that the products in question have been certified as more environmentally friendly than most other similar products throughout their life cycle. According to Chen, Lin and Weng (2015), environmentally friendly consumer behaviour includes purchasing behaviour that includes reading labels, buying reusable materials, and recycling goods.

Informing consumers about the sustainability, durability, consumption, maintenance and disposal options of products not only raises their awareness but also increases their responsible consumption habits. **According to (CosumerPro, 2022), the most common ways in which consumers are informed about a product's level of sustainability are:**

- **Eco-design**
- **Energy labelling**

A detailed discussion of the three forms of consumer information on the sustainability of products is given below Eco-labelling:

Eco-design

Eco-design encourages manufacturers to improve products through more efficient use of resources throughout their life cycle - for example, through repair requirements. Product quality and usability must also be taken into account. Consumers are required to be given more information on the sustainable use of the product. The EU Ecodesign Directive76 not only protects the environment but also helps consumers save money. According to a 2016 survey77 commissioned by BEUC, the average EU household can save up to €330 per year through eco-design and by making products more energy efficient over time.

According Wojnarowska (2021), Eco-design also plays an important role in the implementation of a company's environmental policy, which includes adapting to the criteria established for specific eco-labelling. According to Directive 2009/125/ CE [Directive 2009], eco-design involves the regular incorporation of the environment life cycle perspective into the design of products, services, and processes. Eco-design entails embedding environmental aspects in the product design with the aim of improving its eco- effectiveness throughout its life cycle. The eco-design process results in an environmental profile describing outlays and products related to a given product throughout its life cycle that are significant from the point of view of its environmental impact and are expressed in measurable physical terms. Continual modifications can be observed in the extent to which a company perceives its role in economic development and its importance in satisfying comprehensive social needs and requirements. New phenomena in the domain of consumption, production, and cooperation between respective market participants have given rise to some very dynamic and interdisciplinary issues.

Energy labelling

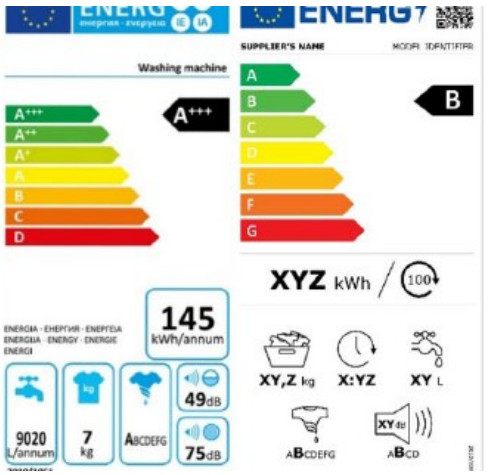
The Energy Labelling Regulation 78 empowers the European Commission to adopt mandatory labelling measures for specific energy-related product groups such as washing machines and televisions. This ensures that consumers can make an informed choice about the energy consumption of products during use.

According to 24take (2024), as climate change is intensifying, intensive efforts are being made to reduce electricity consumption in a wide range of activities, and residential households are no exception. The Energy Labelling Directive adopted by the European Union not only contributes to a more sustainable use of household appliances, but also has financial benefits for consumers. With electricity prices rising, many consumers are choosing to buy more economical, resource-efficient appliances that will save them money in the long term.

Energy efficiency classes are a way of determining the amount of electricity consumed and an efficiency index. The old system, which ran on a scale from A++ to D (lowest efficiency), was replaced in 2021 to encourage manufacturers to improve appliances and develop new, more efficient and sustainable technologies. The new categorisation of A, B, C, D, E, F and G is not only clearer for consumers, but also allows for uniform labelling between different manufacturers and increases common standards for appliances. The system applies to fridges and freezers, washing machines, tumble dryers, ovens, hoods and dishwashers.

The highest energy class, A, is the most efficient and wastes the least electricity. These appliances are the friendliest to the environment and to your wallet, as they consume the most resources. The second B category appliances, although they consume slightly more energy, are also efficient and economical. Class C and D appliances are classified as medium energy savers. Appliances in the low energy efficiency category (E, F and G) will use significantly more resources, so you need to consider both environmental and financial aspects when choosing such appliances. It is also important to remember that even an old appliance with the highest energy rating will consume more energy than a new appliance with a medium rating, so investing in a periodic renewal of your appliances will also be worthwhile.

When we buy home appliances or electronics, we are used to seeing an energy efficiency label with all the relevant information about the product's consumption. Sellers are obliged to provide this label in both physical and online shops.



EcolabelLING

According Wojnarowska (2021), Eco-labels are a way to tell consumers how much a product impacts the environment throughout its life. These labels look a specific way and show that a product meets certain environmental standards. This means producers can't just put an eco-label on anything they want. While not mandatory, eco-labels can only be used if they follow strict rules. Essentially, eco-labels set products apart by highlighting their lower environmental impact compared to similar ones. They often focus on comparing how easy a product is to use while considering its environmental footprint. Some labels even consider social factors beyond the environment.

The EU Ecolabel was established in 1992 as a Europe-wide optional label to help consumers make greener and healthier purchasing decisions. The Ecolabel now covers more than 77,000 products and services in 24 different categories. This number has almost doubled since 2016.

To qualify for the 'flower' logo, a product or service must meet a list of environmental and health-related criteria, from the durability of the product to the exposure to harmful chemicals.

There are other eco-labels officially recognised at national or regional level in the EU which are equivalent to the EU Ecolabel. Examples of such labels include, for example, the "Nordic Swan" in the Nordic countries, the "Blue Angel" in Germany or the Austrian ecolabel.

By providing sustainable information, eco-labels help consumers trust products that are better for the environment. However, for them to be effective, consumers need to understand and trust the labels themselves. Unfortunately, there can be issues with how these labels are monitored, which can make them less reliable.

One of the main goals of eco-labels is to encourage consumers to be more environmentally conscious and choose sustainable products (Wojnarowska, 2021). This, in turn, pushes businesses and governments to offer and make products that meet higher environmental standards. Ultimately, eco-labels aim to create a market for more environmentally friendly goods.

According to Wojnarowska (2021), **there are several benefits to eco-labels**:

- including promoting environmentally friendly products,
- informing consumers,
- encouraging businesses to be more sustainable,
- and educating the public.

The most important role, however, is **helping consumers identify products that are better for the environment**. Eco-labels are a powerful tool for influencing consumer choices and promoting sustainable products.

Sustainable consumption is becoming increasingly important for both consumers and businesses. In order to reduce environmental impacts and promote social responsibility, it is important not only to produce sustainable products, but also to encourage consumers to choose them. Consumers are increasingly interested in the environmental and social impact of the products they buy, which is why eco-labelling is becoming increasingly important. The EU Ecolabel and other nationally or regionally recognised labels guarantee that products meet strict environmental and health criteria. In addition to eco-labelling, other measures such as consumer education, the production of durable products, the use of recycled materials and the responsible management of waste can also help promote sustainable consumption. Sustainable consumption is vital for a more sustainable future and all stakeholders - governments, businesses and consumers - need to work together to make it happen.

Takeaways

Importance of Consumer Awareness:

- Sustainable consumption relies heavily on informed consumers. Governments and businesses play a crucial role in providing accurate and comprehensive information about the environmental and social impacts of products. Eco-labelling, energy labelling, and eco-design are essential tools for raising consumer awareness and promoting environmentally friendly purchasing decisions.

Role of Eco-Design:

- Eco-design focuses on improving products by making them more resource-efficient throughout their life cycle. This not only benefits the environment but also helps consumers save money in the long run. The EU Ecodesign Directive, for example, ensures that products are designed with both environmental protection and cost savings in mind.

Significance of Energy Labelling:

- Energy labelling is a critical component in guiding consumers towards energy-efficient products. The updated EU Energy Labelling Regulation provides clear and uniform labels that help consumers make informed choices, leading to reduced energy consumption and financial savings. The categorization from A (most efficient) to G (least efficient) allows for easy comparison between products.

Impact of Eco-Labelling:

- Eco-labelling helps consumers identify products that have a lower environmental impact throughout their life cycle. Labels like the EU Ecolabel provide assurance that products meet stringent environmental and health criteria. This encourages sustainable consumer behavior and pushes businesses to adopt higher environmental standards, fostering a market for greener products.

Ideas to consider

Enhanced Consumer Education Programs:

- Governments and businesses should invest more in consumer education programs that emphasize the importance of sustainable consumption. Educating consumers on the benefits of eco-design, energy efficiency, and eco-labelling can significantly influence purchasing behaviors and promote a more sustainable market.

Incentivizing Sustainable Choices:

- Implementing incentives for purchasing environmentally friendly products, such as tax breaks or rebates, can encourage more consumers to choose sustainable options. Additionally, providing subsidies for manufacturers to produce eco-friendly products can help drive the market towards sustainability.

Strengthening Eco-Labelling Standards:

- To ensure the reliability and effectiveness of eco-labels, it is crucial to develop and enforce stringent standards. Regular monitoring and certification processes can maintain the integrity of eco-labels, making them a trusted source of information for consumers.

Promoting Sustainable Product Design:

- Encouraging manufacturers to integrate sustainability into the design process can lead to products that are not only environmentally friendly but also durable and cost-effective. Policies that support the development and adoption of eco-design principles can drive innovation in product design.

Collaborative Efforts for a Sustainable Future:

- Achieving sustainable consumption requires collaboration between various stakeholders, including governments, businesses, and consumers. Public-private partnerships, industry collaborations, and community initiatives can collectively work towards creating a more sustainable economy and society. By pooling resources and expertise, these collaborative efforts can have a more significant impact on promoting sustainable consumption practices.

Audiovisual Material

Sustainable Consumption
https://www.youtube.com/watch?v=RYFEL7RJTmU
How to make sustainable consumption possible?
https://www.youtube.com/watch?v=XeoCfBg9eSY
What are Eco-Labels or Sustainability Labels? Different types of Eco Labeling.
https://www.youtube.com/watch?v=XbgbGE_fqe0
Measures to support energy-efficient products and services: Ecodesign, eco-labels and green...
https://www.youtube.com/watch?v=EOQpOzAtpFQ

4.7 End-of-Life Management

According to Wray& Veer (2024), the circular economy as "a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste, and pollution" based on three principles driven by design:

- eliminate waste and pollution;
- circulate products and materials (at their highest value);
- regenerate nature.

Transitioning to a circular economy will place significant demands on manufacturers and designers. Two trends characterize current consumption patterns: consumers have more products than before, but at the same time most of them are being used for a much shorter period. Shorter life spans and more frequent replacement are leading to an increased need to use resources for production. Research on product lifetimes has recently shown a trend towards decreasing lifetimes. However, the motivation of consumers to change products more frequently than in the past is not yet fully clear. This can be attributed to changing consumer attitudes, early product deterioration and marketing pressures that encourage consumerism. Surprisingly, although some products are replaced after a short period of use, some studies show that consumers want products to last much longer and that information on product durability is important to them.

Moreover, according to ConsumerPro (2022), many consumers are disappointed if the products they buy do not meet their expectations. Very often, products that are essential for a comfortable lifestyle, such as washing machines, electric toothbrushes, televisions, printers and smartphones, break down shortly after the end of the warranty period and cannot be repaired.

Obsolescence and lack of repairability is a multifaceted problem; it can include intentional and unintentional product failure due to faulty design, failure to maintain, repair or install updated software. Sometimes there is also consumer dissatisfaction with the current performance of a product, which leads to product replacement - i.e. although the product purchased works, it no longer meets the consumer's expectations and is replaced.

In order to minimise waste at the end of the product life cycle, it is essential to implement effective recycling, reuse and disposal strategies. Designing products for easy disassembly and recycling, implementing take-back programmes and promoting the re-use of products or components can help to close the loop and reduce waste

The Circular Economy Action Plan specifically mentions the fight against programmed obsolescence. The EU Circular Economy Action Plan (2020) also provides an outline of such future measures:

- **Making more products sustainable.** The future Sustainable Product Policy Framework (*SPPF*) is expected to make many more consumer products, such as smartphones and computers, more durable, reusable, renewable, repairable and recyclable.
- **Highly polluting sectors** such as textiles and buildings are expected to use raw materials more efficiently. The high-profile ban on single-use plastics, which the EU institutions pushed through in record time, is now seen as a good model and a source of inspiration for sector-specific rules.
- **Consumers' "right to repair" will gain new momentum.** More consumer products will need to be easily repaired and updated. Smartphones, coffee machines and printers should be at the top of the priority list, as they are the ones that receive the most consumer complaints in Europe.

Consumers will get more reliable information on **durability and reparability**. For example, in future, companies may have to disclose at the point of sale how long their products will last or how long the supply of spare parts will be guaranteed. Consumers will be better protected against "green brainwashing" and premature obsolescence. This means that the European Union will seek to prevent unsubstantiated advertising claims of green products and stop fraudulent ageing.

The European Commission is committed to creating a culture of product repair, and recent measures to implement the Ecodesign Directive show that providing the opportunity to repair is a very concrete way to extend product life. It is important to maintain access to spare parts over time, and information on repair and maintenance options must be easily accessible. **Building on existing instruments, the European "Right to Repair" can be implemented, in particular for ICT products:**

- Availability of spare parts - at least for the expected lifetime of the products. This can also be extended to software parts, as is already the case for servers.
- Accessible instructions for use and repair.
- A design that provides for easy repairability - i.e. there must be easy access to the parts that need to be repaired or replaced.
- Information at the point of sale on the 'repairability' of the product - possibly using a repairability rating system.

Our consumption habits are becoming increasingly disposable, with shorter product lifespans driven by various factors. However, consumers still desire durable goods and are frustrated by early product failure. To combat this trend, the EU's Circular Economy Action Plan promotes product sustainability through increased durability, resource efficiency, and the "Right to Repair" initiative. This plan includes mandatory spare parts availability, accessible repair information, repairable product design, and potential repairability rating systems. These measures aim to extend product lifespans, reduce waste, and transition towards a more circular economy.

Takeaways

Importance of Design and Policy:

The text emphasizes the critical role of product design and policy in promoting sustainability. Designing products for easy disassembly, recycling, and repair, coupled with policies like the EU's Circular Economy Action Plan, can significantly reduce waste and enhance resource efficiency.

Challenges of Consumer Behavior:

Consumer attitudes and behaviors play a significant role in the lifecycle of products. While consumers desire durable goods and are concerned about early product failure, they are also influenced by marketing pressures and the perception of product obsolescence, leading to shorter product lifespans and increased waste.

Initiatives to Combat Obsolescence:

The EU's initiatives, such as the "Right to Repair" and Sustainable Product Policy Framework, aim to combat programmed obsolescence. These initiatives promote longer-lasting products, access to spare parts, and clearer information on product durability and repairability, empowering consumers to make informed choices.

Benefits of Transitioning to a Circular Economy:

Transitioning to a circular economy offers numerous benefits, including extended product lifespans, reduced waste generation, and enhanced resource efficiency. By implementing strategies like effective recycling, reuse, and disposal, we can close the loop on product lifecycles and minimize environmental impact.

Ideas to consider

Design for Durability and Repairability:

Manufacturers should prioritize designing products that are durable, easy to repair, and upgradeable. This includes ensuring access to spare parts and providing clear instructions for maintenance and repair.

Promote Consumer Awareness:

Educating consumers about product durability, repair options, and the environmental impacts of their purchasing decisions can empower them to make more sustainable choices. Transparent information at the point of sale about a product's lifespan and repairability can influence consumer behavior positively.

Support Policy Initiatives:

Advocating for and supporting policies that promote the circular economy, such as the EU's Circular Economy Action Plan and the "Right to Repair" initiatives, can create a regulatory framework that incentivizes manufacturers to produce longer-lasting and more sustainable products.

Encourage Recycling and Reuse Programs:

Implementing effective recycling programs, promoting the reuse of products or components, and establishing take-back schemes can help close the loop in product lifecycles. These initiatives reduce waste and conserve resources by reintroducing materials into the production cycle.

Innovate Sustainable Farming Practices:

Farmers can contribute to sustainability efforts by adopting practices that minimize agricultural waste, improve soil health, and reduce the environmental footprint of farming operations. Embracing sustainable agricultural techniques aligns with the broader goals of the circular economy by promoting resource efficiency and environmental stewardship.

These ideas underscore the importance of collaborative efforts among manufacturers, consumers, policymakers, and agricultural stakeholders to advance sustainability and achieve the goals of a circular economy. By implementing these ideas, we can collectively work towards reducing waste, conserving resources, and mitigating environmental impacts.

Audiovisual Material

How to Develop an End of Life Policy:
https://www.youtube.com/watch?v=AucSlBLVTIU
Life Cycle Engineering — End-of-Life Management
https://www.youtube.com/watch?v=GKM42UU6lqM
EU Eco-innovation policies: Electronics product End-of-Life & waste management
https://www.youtube.com/watch?v=115MUWx6nDg

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