Module 2

Elements to Consider in the Selection of Waste Materials

Introduction

This module focuses on the characterization of materials came from domestic, agricultural or industrial sphere that have been used and have reached the end of their life cycle, i.e., materials categorized as waste. Participants will receive general knowledge about materials, which will be useful for understanding and approaching materials considered as waste. They will then learn about the intrinsic chemical-physical characteristics of these materials, their origin, and their use as finished products.

Duration: 5h

Objectives:

General Objectives

At the end of this module, participants will be able to distinguish the materials presented and will be able to put into practice the notions learnt during the module, critically approaching the issues of correct identification, processing and disposal or creative reuse (reduce, reuse, recycle).

Specific objectives

the participants will be able to

- distinguish waste in its different types and draw the necessary information from the different sources
- distinguish and identify the material according to its characteristics
- demonstrate understanding and the ability to apply the acquired knowledge in everyday life

Framework of module 2				
Duration	**Venue**	**Methodology**	**Output**	**Learning Outcome:**
Session 1		**Concept of waste materials**		
1h	Training hall	Presentation Roleplay Q&A session Group discussion Sharing thoughts NEW: Presentation, Q&A session, Group discussion (role-play optional based on time and relevance)	Participants will understand about waste material and associated issue.	reflective diaries, verbal feedback, semi-structured interview form with open-ended questions, process outputs (drawing, audio, visual materials created by the participants) NEW: Short written reflections or verbal feedback; optional creative outputs (e.g., drawings, photos, short videos).
Session 2A - Exploration of the material's characteristics by general characteristics - Part 1: Metals, Glass, Paper				

1h	Training hall	Presentation Q&A session Group discussion Group work General discussion Competition Sharing thoughts	Participants will be able to identify and distinguish between metals, glass, and paper based on their physical and chemical properties. They will also understand production processes and recyclability, and reflect on their environmental impact.	Reflective diaries Verbal feedback Semi-structured interviews with open-ended questions Process outputs (drawings, audio, visuals created by the participants)
Session 2B - Exploration of the material's characteristics by general characteristics - Part 2: Plastics and Textiles				
1h	Training hall	Presentation Q&A session Group work General discussion Competition Sharing thoughts	Participants will be able to distinguish plastics and textiles by general physical and structural properties. They will critically reflect on recyclability, microplastics, biodegradability, and socio-environmental implications.	Reflective diaries Verbal feedback Semi-structured interviews with open-ended questions Process outputs (drawings, audio, visuals created by the participants)
Session 3	**Exploration of the material's characteristics by differentiation techniques**			
1h	Training hall	Presentation Q&A session Group discussion Group work General discussion Competition Sharing thoughts	Participants will be able to identify and distinguish between paper and plastic material from waste, on the bases of the material's characteristics and suggest the correct reduce, reuse and recycle, describing it.	reflective diaries, verbal feedback, semi-structured interview form with open-ended questions, process outputs (drawing, audio, visual materials created by the participants)
Session 4	**Communicating to others how to distinguish the different materials examined**			
1h	Training hall	Presentation Q&A session Discussion Sharing thoughts Roleplay	Participants will have to create a presentation in which they suggest innovative and more appealing ways to present materials and push people towards more responsible behaviour.	reflective diaries, verbal feedback, semi-structured interview form with open-ended questions, process outputs (drawing, audio, visual materials created by the participants)

Session 1: Concept of waste materials

Duration: 1 hour

Resources Required

- Hand out
- Flip chart
- Reference materials
- Markers
- notes

Methodology:

- Presentation
- Q&A session
- Group discussion
- Role-play optional based on time and relevance

Output:

Participants will be able to distinguish between waste categories based on their production, the steps in the management of these materials and the hierarchy of roles involved.

Procedure:

- Enable the participants to understand what waste material and which categories is existing through a presentation (20min).
- Divide the participants into groups representing ordinary citizens, Europe, mayors of different cities with different disposal facilities, heads of industry and give to each group the relative role materials
- Each group should present its position and the role it will play in the debate (10min)
- Groups should discuss possible solutions, rules and strategies to recover as many resources as possible from the waste and dispose of the rest in the least environmentally impactful way possible (30min)

Questions:

1- what is waste?
2- what are the differences between household, agricultural and industrial waste?
3- how does waste classification take place?
4- what is the impact of these materials on the environment?
5- if you need information where you can have answer?
6- which authority oversees the proper handling of waste materials?

Origin and definition of waste

According to the Waste Framework Directive, issued by the European Parliament in 2008, Article 3: waste is "any substance or object of which the holder discards, or intends or is obliged to discard."

Waste production has existed since the dawn of humanity. Nomadic hunter-gatherers lived without producing lasting waste. Any refuse was naturally reintegrated into the environment, enriching the land and creating new resources. The balance between waste production, disposal, and reintegration into the

environment was disrupted by the shift to a sedentary lifestyle. Initially, waste management was divided as follows: food scraps were given to animals, tools, and equipment were passed down through generations. Even the processing of materials like metals or ceramics had a minimal environmental impact. With the growth of cities, the problem of waste became more complex. The management of biological and artisanal waste was neglected to the point of becoming a major factor in fueling devastating epidemics. Waste management in ancient civilizations began with the ancient city of Knossos on Crete, where as early as 3000 BC, deep pits were dug to bury waste underground. Despite efforts, ancient Greek cities lacked adequate sanitation systems, contributing to epidemics such as the plague that struck Athens in 432 BC. Even in ancient Rome, outside the city walls, layers of waste accumulated, creating veritable hills of garbage. Pre-industrial civilizations possessed a recycling-oriented mentality, despite the hygienic limitations. During the Renaissance, the first urban structures for waste management were developed, but the unexpected impact of consumerism linked to the Industrial Revolution rendered all these efforts inadequate. In the 19th century, the Industrial Revolution drastically changed the organization of cities. With urbanization, cities became overpopulated, and waste production increased exponentially. It was only in the following decades that the first waste bins appeared, but in the meantime, technological progress had introduced unsustainable materials, increasing the production of single-use products and packaging.

what are the differences between waste?

The first major distinction made when discussing waste is between hazardous and non-hazardous waste. Hazardous waste is any waste that exhibits one or more of the following characteristics:

Ignitability, Toxicity, Reactivity, Corrosivity and Environmental hazard. Examples include batteries, paints, solvents, used oils, expired medications, fluorescent lamps, medical waste, and industrial waste containing hazardous substances. These wastes must be collected, transported, and disposed of safely, often requiring specific treatments to neutralize or reduce their hazards. Non-hazardous waste, on the other hand, is any waste that, while requiring proper disposal, does not exhibit hazardous properties such as flammability, toxicity, reactivity, or environmental hazard. Examples include paper, cardboard, glass, plastic (if not contaminated), organic food waste, and untreated wood. Management: Generally, non-hazardous waste is collected separately and destined for recycling or disposal in controlled landfills. It is important to distinguish between the two types of waste to ensure proper management, safeguarding ecosystems, biodiversity, and human health.how does waste classification take place?

Each waste is identified with an EWC code, assigned by the producer according to the type of production.

We can make another inner division into 3 types of sources from which waste is derived:

1.Domestic (Municipal) Waste, is that produced by daily activities in private homes and communities such as boarding schools, colleges, schools, hotels, etc. This category includes: Paper, glass, plastic, metals, food waste, textiles, packaging, organic waste, electrical and electronic equipment, batteries, bulky waste such as furniture and mattresses, and more.

2. Agricultural wastes come from agricultural and livestock activities, including. This category also includes: Vegetable waste, pesticide containers, fertilizers, agricultural plastics (nets, tarps), manure. If poorly managed, agricultural waste can contaminate soil and groundwater.

3. Industrial Waste, are those wastes generated by manufacturing, handicraft and industrial activities. These wastes are generated in the surfaces used for industrial processing, in warehouses of raw materials and finished products. We can find Vehicle carcasses, tires, chemical wastes, technical plastics, hazardous wastes such as solvents and paints.

Another specific division of the waste is made by chemical composition, physics, properties, and use of the objects became waste.

What is the impact of these materials on the environment?

Open-air landfills pose significant economic and, more importantly, environmental risks. These landfills contain electrical materials, industrial waste, everyday items like batteries and appliances that can release hazardous substances into the soil, as well as clothing and textiles, particularly fast fashion waste, which also contain slowly released hazardous substances.

The side effects of these landfills are numerous and devastating: contamination of groundwater, pollution of agricultural soil, and the release of toxic waste into the air through incineration. The health consequences for local communities are severe, with high rates of respiratory diseases, cancer, and dermatological problems. While local pollution may seem contained, the long-term economic and climate consequences are global. By 2025, open-air landfills could be responsible for 8-10% of global greenhouse gas emissions, further exacerbating the climate crisis.

In addition to pollution, there is the economic factor. In the world's poorest countries, landfills are often managed fraudulently, exploiting poverty by offering meager financial compensation to people, often children, to recover materials from these landfills without providing any personal protection against the aforementioned dangers.

If you need information where you can have answer?

which authority oversees the proper handling of waste materials?

Let's take a sheet of paper as an example: if I write on it, it remains a normal piece of paper. However, the moment I decide I no longer need it and throw it away, that sheet becomes legally classified as waste. This step is not at all trivial, as a series of significant implications are triggered from that moment on. First of all, the sheet is virtually assigned a six-digit code, specifically 200101, which identifies it as 'paper and cardboard for separate collection', thus establishing its future path. This code, along with hundreds of others, can be found in Chapter 20 of the European Waste Catalogue (EWC). The EWC is a long list of codes that includes every type of waste produced by our society, not only urban waste but also industrial, commercial, agricultural, and so on. Once a waste receives its code, it becomes subject to a series of rules that govern its collection, treatment, recovery, and disposal. The aim of these rules is to prevent, or at least minimize, any damage that improper waste management could cause to public health and the environment.

In the 1970s, with the first European Community Action Programs, the foundations were laid for environmental legislation that placed the protection of human health and the environment at the center. Framework Directive 75/442/EEC introduced the concept of “waste” and established the first standards for disposal.

Directive 91/156/EEC strengthens environmental protection and introduces a shared definition of waste management, emphasizing the importance of prevention, recovery and recycling.

With the 5th Action Program and the Packaging Directive 94/62/EC, the principle of sustainable development is affirmed and the waste hierarchy is introduced, with priority given to prevention, reuse and recycling over disposal.

In subsequent years, legislation is further refined with the introduction of specific directives on landfilling (1999/31/EEC) and incineration (2000/76/EC), which aim to reduce the environmental impact of these practices.

This directive represents a milestone, consolidating the principles of prevention, reuse and recycling and introducing binding targets for waste reduction.

The latest chapter in this evolution is the 2018 European Package, which introduces ambitious targets for recycling of municipal and packaging waste, promotes separate collection, and combats food waste. Directives 2018/849, 2018/850, 2018/851 and 2018/852 update and strengthen existing legislation, introducing new obligations for member states.

Session 2 Exploration of the material's characteristics by general characteristics

Part 1: Metals, Glass, Paper

Duration: 1 hour

Resources Required:

- Handouts
- Flip chart
- Reference materials
- Markers
- Notes

Methodology:

- Presentation
- Q&A session
- Group discussion
- Group work
- Sharing thoughts

Procedure:

1. Enable the participants to understand what the key material properties are and where they come from using Q&A approach, presentation and media (20 min).
2. Divide the participants into 3 groups: Metals, Glass, Paper. Each group explores the material's general characteristics, usage, recyclability, and impact.
3. Group discussion and presentation of observations (25 min).
4. Final joint discussion on similarities/differences and what issues arose in identifying the materials (15 min).

Questions:

- How are materials produced?
- Are the differences between materials clear or similar in most cases?
- Is it easy to distinguish different materials?
- How do these materials impact the environment, animals, and our lives?
- Can all these materials be recycled?
- How many trees are needed to produce recycled paper?

Output:
Participants will be able to distinguish the proposed waste materials by general notions and stimulating activities. They will also develop a critical sense toward the materials' environmental impact and management.

Metals
Metals are divided into:

- **Ferrous**: Steel and cast iron
- **Non-ferrous**: Aluminum, copper, lead, zinc, brass, etc.

Metals are composed of atoms that tend to lose their outermost electrons, resulting in unique properties:

- Luster
- Ductility (can be drawn into sheets)
- Malleability (can be deformed without breaking)

Production process:

1. Locate ore deposits (metals are not found in metallic form except for gold/silver).
2. Extract minerals from mines.
3. Enrich and separate metal from impurities.
4. Apply metallurgical processes to obtain pure metal.

Properties:

- Heavy or lightweight (e.g., aluminum)
- Hardness, density, melting point
- Electrical and thermal conductivity

Recyclability:

- 100% recyclable
- Retain properties after melting
- Energy-efficient compared to virgin metal production

Glass
Glass is **not a crystal**; its molecules are disordered like a liquid but rigid like a solid.

Production:

- Made from silica (sand), with soda and lime added
- Melted into "molten glass" and shaped

- Rapidly cooled to prevent crystallization (tempering)

Characteristics:

- Transparency
- Hardness
- Chemical resistance
- Thermal and acoustic insulation

Environmental considerations:

- Infinitely recyclable without quality loss
- Improper disposal = thousands of years to decompose
- Essential to reduce waste and environmental footprint

Paper
The raw material is **lignin**, processed into fibrous pulp:

1. Separate fibers, remove impurities
2. Spread pulp on wire cloth
3. Remove water, press, dry, calender, finish

Types:

- Printing, writing, packaging, photographic paper, cardboard

Treated with:

- Additives like inks, acids (sometimes hazardous)

Properties:

- Hygroscopicity
- Opacity
- Crease resistance
- Flexibility

Recycling & biodegradability:

- Easily recyclable but quality degrades with cycles
- Biodegradable but contributes to deforestation
- Eventually fibers become too short for reuse

Session 2B - Exploration of the material's characteristics by general characteristics

Part 2: Plastics and Textiles

Duration: 1 hour

Resources Required:

- Handouts
- Flip chart
- Reference materials
- Markers
- Notes

Methodology:

- Presentation
- Q&A session
- Group work
- General discussion
- Competition
- Sharing thoughts

Procedure:

1. Presentation and Q&A to introduce plastics and textiles (20 min)
2. Divide participants into 2 groups: Plastics and Textiles.
3. Each group explores similarities and differences among the materials (25 min)
4. Competitive activity: identify as many shared/different characteristics as possible
5. Final discussion on challenges encountered (15 min)

Questions:

- How are materials produced?
- Are materials distinguishable or too similar?
- Are all materials recyclable?
- What impact do these materials have?

Output:
Participants will be able to identify, compare, and reflect critically on the general properties of plastics and textiles. They will become aware of the broader implications for sustainability and recycling.

Plastics
Synthetic materials formed through chemical processes. Structure made of long polymer chains.

Raw materials: Derived mainly from petroleum, refined into monomers, then polymerized.

Types:

- **Thermoplastics**: Re-moldable (e.g., polyethylene, polypropylene, PVC)
- **Thermosets**: Not re-moldable (e.g., epoxy, bakelite)

Properties:

- Lightness
- Resistance (weather, impact)
- Electrical/thermal insulation
- Moldability and low cost

Visual confusion:

- Can resemble glass or paper
- Sometimes only fire tests or chemical analysis can identify them

Environmental impact:

- Take centuries to degrade
- Pollute soil, water, and air
- Require fossil fuels and emit GHGs during production

Solutions:

- Develop biodegradable and low-impact plastics
- Policies to reduce single-use plastics

Textiles
Made of **fibers**, either **natural** (cotton, wool, silk) or **synthetic** (polyester, nylon, acrylic)

Properties depend on:

- Fiber type (e.g., cellulose, keratin, fibroin)
- Physical structure
- Finishing and dyeing processes

Natural fibers:

- Cotton: Strong, absorbent
- Wool: Warm, elastic
- Silk: Lightweight, shiny

Artificial fibers:

- Viscose, acetate (from cellulose)

Synthetic fibers:

- Derived from petrochemicals
- Durable, cheap, but hard to recycle

Production impact:

- High water use in dyeing
- Chemical pollution from dye runoff

Environmental footprint:

- Natural = biodegradable, but affected by treatments
- Synthetic = microplastic release, long degradation time

Reuse & recycling:

- Upcycling for damaged textiles
- Synthetic fiber recycling is complex but possible

Session 3 Exploration of the material's characteristics by differentiation techniques

Duration:1 hour

Resources Required

- Hand out
- Flip chart
- Reference materials
- Markers
- notes
- waste materials from class, school and snack break (no cutting materials) and representative photos

Methodology:

- Presentation
- Q&A session
- Group discussion
- Group work
- General discussion
- Competition
- Sharing thoughts

Procedure:

- Enable the participants to explain what are the key material properties, where they come from using Q&A approach, and explain how it's possible divide it by different methodology use a presentation and videos (30 min).
- Divide the participants into groups and give them different materials to sort and dispose of properly or give them signed post-it to put on object in the room
- Start the competition on which group finishes the distinction first and succeeds in diversifying products better
- Final discussion on how easy or difficult it was to divide the material provided and what the major problems were

Questions:

1- what are the best practices for selecting material?
2- differentiation is alway simple?
3- now what are the strategy to implement this process?

Output

Participants will be able to distinguish the proposed waste materials by general notions and fun and stimulating activities. At the end of the activities, they will also develop a critical sense in this regard.

what are the best practices for selecting material?

The first step in the reuse process is the sorting of materials, that is, the separation of waste according to its physical and chemical composition. This process can be carried out manually or through advanced technologies using automatic detection and separation mechanisms. In the recycling industry, sorting techniques include optical recognition systems, which use sensors and cameras to identify the composition of materials. Other sistems are based on dimension of piece. Other optical system are combined with chemical analysis like IR-spectroscopy. One example is plastic, metallic, and paper materials can be separated automatically using optical scanners that detect their color, density, and texture. Magnetic recognition systems are another commonly used technology for separating ferrous metals from other materials. This process uses magnetic fields to attract ferrous materials, facilitating their separation from plastic, wood, and other nonmagnetic.

differentiation is alway simple?

Contamination of waste materials, for example, is a major challenge in the reuse process. Materials contaminated with hazardous chemicals or materials that are difficult to separate can reduce the quality of reuse and increase process costs.

Despite technological advances, the selection of reusable materials still presents several challenges. One of the greatest difficulties is the complexity of modern waste, which often contains composite materials that are difficult to separate. For example, e-waste contains a wide range of metals, plastics and other materials that must be carefully separated to ensure efficient reuse.

now what are the strategy to implement this process?

Traditional methods for waste sorting include manual separation: a time-consuming, expensive, and inefficient process that can only be applied to small volumes of waste. Another method is mechanical separation, which relies on physical properties like density, shape, and size to separate materials. However, the effectiveness of these mechanical systems is hindered by the presence of contaminants and the wide variety of waste materials, which can make it difficult to achieve a high degree of purity in the sorted materials. Advanced optical and magnetic recognition techniques, along with the use of new technologies such as artificial intelligence, are revolutionizing the industry, improving efficiency and reducing costs.

Session 4- Communicating to others how to distinguish the different materials examined and how communicate a positive message

Duration: 1 hour

Resources Required

- projector
- pc
- paper notes
- pen

Methodology:

- Presentation
- Q&A session
- Discussion
- Sharing thoughts
- Roleplay

Procedure:

- divide participants in 4 groups, give the resume supporting materials from the previews meet
- participants discuss each other for create a presentation
- present the ideas at class
- discussion about the presentation and ideas

Questions:

1- Is it important to characterize materials to improve waste management?
2- How is sorting waste useful?
3- Are there any creative solutions to engage more people in recycling and reusing objects?
4- provide examples of reuse of material explaining why it can be done

output

Participants will have learnt the notions presented so far and will be able to talk about them and play an active role in the dissemination of knowledge.

Is it important to characterize materials to improve waste management?

Recycling and reuse offer significant environmental benefits, but they also present different challenges and opportunities. One of the main differences between the two strategies concerns the management of costs and resources. Recycling requires investments in infrastructure, technology, and industrial processes, while reuse is based on the direct valorization of existing materials, without the need for complex transformation processes. However, reuse can be limited by the availability of suitable materials and the creativity required to reinvent their uses. On the other hand, recycling, although more energy and resource-intensive, can be applied on a larger scale, providing a structured solution for managing large volumes of waste materials.
The substantial differences are:

State of the good: Reuse occurs before a good becomes waste, while recycling applies to goods already classified as waste.

Process: Reuse can occur with minimal modifications or repairs, while recycling involves a deep transformation of the material.

Environmental impact: Reuse tends to require less energy than recycling, as it does not require complex industrial processes.

Circular economy: Both are fundamental, but reuse is preferred as it better preserves the original resources of the product, while recycling creates new secondary raw materials.

In summary, reuse is a more immediate practice and less energy-intensive, while recycling is a more intensive process that recovers materials once they have already become waste. Both, however, play a fundamental role in the sustainable management of waste and in promoting the circular economy.

Are there any creative solutions to engage more people in recycling and reusing objects?
Examples of raising awareness and using waste can also be found in the artistic context. Sustainability is not only a response to global environmental challenges, but also a means through which artists can express critical visions of consumer society, pollution, and resource management. Artistic sustainability helps reduce the environmental impact of creative activities, while at the same time raising public awareness of ecological issues. This includes the use of recycled or reused materials, rather than new ones, the adoption of low-energy techniques, and the promotion of ecological messages through works. Contemporary artists who embrace sustainability often work with unconventional materials, such as industrial waste, recovered plastic and glass, or natural materials like wood and mycelium. Being sustainable in art can actually save you money! Using recycled or reused materials is usually cheaper than buying new stuff.