PACKALL

PackAlliance:
European alliance for innovation training
& collaboration towards future packaging

R3.2 Training contents

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Glossary of terms, abbreviations and acronyms

Abbreviation / Acronym / Term	Description
CE	Circular Economy
CHAINs	CHAllenges INnovation teams. Collaborative teams of students of the PackAlliance postgraduate programme to work on a specific industry challenge
EACEA	Education, Audiovisual and Culture Executive Agency
HEI	Higher Education Institution
PackAlliance Hubs	Physical places where the academia-industry collaboration within the project will take place
WP	Work Package

Partner shortname	
P1-Campus Iberus	Partner 1 - Campus Iberus (Spain)
P2-Ecoembes	Partner 2 - Ecoembes (Spain)
P3-AGH	Partner 3 - AGH University of Science and Technology (Poland)
P4-Synthos	Partner 4 - Synthos Group (Poland)
P5-TAMK	Partner 5 - TAMK Tampere University of Applied Sciences (Finland)
P6-Pyroll	Partner 6 - Pyroll Group (Finland)
P7-Proplast	Partner 7 - Consorzio per la promozione della cultura plastica - Proplast (Italy)
P8-UNISA	Partner 8 - Università degli Studi di Salerno (Italy)

Table of contents

1. INTRODUCTION **5**

2. CONTENT OF THE MODULE **6**

2.1. MODULE 1. NEW MATERIALS AND BIO-BASED MATERIALS 7

2.2. MODULE 2. ECO-DESIGN AND NOVEL MANUFACTURING PROCESSING 11

2.3. MODULE 3. RESIDUE MANAGEMENT AND VALORISATION 14

2.4. MODULE 4. CITIZEN AND CONSUMER ENGAGEMENT 16

2.5. MODULE 5. CHAINS 18

LIST OF ANNEXES: **19**

PROJECT INFO **20**

1. Introduction

The report summarizes the results of the work on developing the PackAlliance Program's training curriculum.

The PackAlliance project (funded by Erasmus+ Knowledge Alliance programme in 2020-2022) intends to contribute to modernising the Higher Education curricula by enhancing its alignment with the labour market needs of plastics packaging. The Knowledge Alliance project brings together academic and industry partners from Spain, Poland, Finland, and Italy, in order to foster academia-industry collaboration for innovation and competence building in innovative and sustainable packaging..

The training contents were developed in accordance with Report R2.3 - Characterization of the profile of emerging professionals. The findings of the report include a detailed description of the content as well as a module curriculum. Chapter 2 contains detailed information about the modules' content, including: new materials and biomaterials, eco-design and novel manufacturing processing, citizen and consumer engagement, Residue Management and Valorisation. The syllabus for each module is included in the annexes. Participants in the PackAlliance Pilot Program have access to extensive program information and learning exercises via Campus Iberus' elearning platform.

2. Content of the module

The purpose of this project is to develop a Program for specialists in the circular economy of plastic packaging who will acquire the knowledge, skills, and transversal competencies necessary to carry out activities aimed at transforming the plastic packaging industry toward a circular economy.

The Programme is divided in five thematic modules:

- Module 1. New materials and biomaterials.
- Module 2. Eco-design and novel manufacturing processing.
- Module 3. Residue management and valorisation.
- Module 4. Citizen and consumer engagement.
- Module 5. Challenge-based collaborative practice.

Detailed descriptions of each of the modules are provided in Chapters 2.1-2.5.

2.1. Module 1. New Materials and Bio-Based Materials

The module on new materials and bio-based materials will review the issues related to the knowledge of the possibilities of using innovative materials, including biomaterials in the plastic packaging industry in the context of the development of the circular economy. The module is divided into two parts (Table 1).

The first part is focused on the importance of the latest knowledge in the field of material innovation in solving cognitive and practical problems in the area of circular economy.

The second part is addressed in an entrepreneurial manner. Students will be required to evaluate the environmental consequences of their activities in a professional context.

Table 1. Content description for the module New Materials and Bio-Based Materials

New materials and bio-based materials in plastic packaging sector in the context of development of the CE	
Bioeconomy strategy and legal aspects of use of new materials and bio-based materials in packaging sector	• Definition and strategy of bioeconomy in EU • Scope of the legal aspects in the field of new materials and bio-based materials in packaging sector • The analysis of development directive in the selected EU countries • Future development trends in the development of legal aspects • Analysis of legal acts related to development of new materials and bio-based materials in plastic pacakging sector • Gap analysis of the legal act • Case-studies on the selected countries in the development of the legal regulation related to the topic
Characteristics of the principles of circular economy	• Characteristics of the principles of circular economy • Definition of CE and green deal in the context of new materials and biobased materials • CE versus Linear Economy, value chain idea in the conxtect of new materials and biobased materials • CE in the context of new materials and biomaterials in the EU policy • Tools for monitoring of CE • CE in the in the context of new materials and biomaterials in the selected countries • Comparision between the introduction of the CE in the context of new materials and biomaterials, circular packaging
Characteristics of polymers as raw materials used in the production of packaging materials, including "new"	• Polymer as a chemical molecule • Polymeric reactions • Raw materials for polimers • Polimeric packaging materials

and "bio" and production methods	• Production of packaging materials • Biotechnology in bioplastics production • Characteristics of processing – extrusion, injection moulding, film blowing, compression moulding, thermoforming
Methods of recycling, recovery and reuse of bio-based materials	• Characteristics of material and raw material recycling • Composting requirements and conditions • Energy recycling, combustion with energy recovery, calorific value • Requirements for packaging reuse • Review of packaging return systems, reverse logistics • Identification of barriers and indication of opportunities and threats in packaging waste management
Economic assessment and the value of bioplactic materia	• how to turn bioplastic wastes into an asset for the company; • methods for value calculation; • costs and benefits of bio-based materials from the company point of view; • external effects; how an eco-innovation can work for the company – a Porter hypothesis in practice)
Advantages and disadvantages of the use of new materials and bio-based materials in the context of development of the CE (economical aspects)	• Analysis of determinants for development of the CE in the new materials and bio-based materials • Tools for assessment of the CE • Design the monitoring process of the introduction of the CE • LCC for the introduction of the new materials and bio based materials
Adapting bioeconomy strategies in enterprises in selected courtiers of EU	• Trends in the implementation of bioeconomy strategies in the enterprises in EU • Scope of the implementation of the bioeconomy strategy in selected sectors • Good practices realated to the adaption of the bioeconomy strategies in EU • Future development of the strategies
Circular economy as a tool for promotion biomaterials in the field of packaging - policy challenges in different region	• Introduction of the CE in the field of biomaterials • The promotion of the CE in the field of biomaterials • Analysis of the CE policy implementation in the field of pacagking in the selected regions • Challanges of the CE policy implementation in the field of pacagking in the selected regions
Characteristics of biomaterials in plastic packaging sector	• polymers isolated from biomass of plant and animal origin, which include polysaccharides, lipids and proteins • polymers synthesized by microorganisms or genetically modified plants, polyesters of hydroxy acids (PHA) • chemically synthesized polymers from monomers obtained in the fermentation of biomass, e.g. polylactide (PLA) • polymers obtained from petrochemical raw materials: polycaprolactones (PCL), polyesteramides (PEA), aliphatic copolyesters and aromatic copolymers

Certification and labelling – basic requirements and practise	• Analysis and evaluation of the basic chemical properties of biomaterials (atomic weight, solubility, melting point, etc.) • Comparison of properties of various bioplastics • Characteristics of materials features (physical, mechanical, chemical). • Characteristics of materials physical features (thickness, grammage, barrier) • Characteristics of materials mechanical features (breaking load, elongation, modulus of elasticity) • Development of a material characteristic data sheet
Analysis of the rules of certification and labeling of biomaterials	• Labelling Correctness Assessment Card • Analysis of requirements documents concerning eco-labelling • Product evaluation card in the certification process
Characteristics of new materials and biomaterials, and their types and use	• Analysis and evaluation of the basic chemical properties of biomaterials (atomic weight, solubility, melting point, etc.) • Comparison of properties of various bioplastics • Characteristics of materials features (physical, mechanical, chemical). • Characteristics of materials physical features (thickness, grammage, barrier) • Characteristics of materials mechanical features (breaking load, elongation, modulus of elasticity) • Development of a material characteristic data sheet
Analysis of the suitability of materials for various forms of post-consumer packaging waste management	• Mapping of material flows in packaging management • Practical aspects of packaging waste identification • Processes that prepare post-consumer packaging waste for recycling processes • Processes that prepare biodaradable materials for composting
Case study of chosen solutions on how to turn (bio)plastic wastes into assests for a company calculation	• examples and simulations, how the basic conditions for profitablity can be established; • playing with the predefined simulations students establish the key factors to take into account to ensure profitablility of eco-innovation related to bio-based materials in the plastic
Willingness to pay	• Willingness to pay for plastic packaging in the context of development of new materials and bio-materials • Direct methods of WTP in the example of plastic packaging in materials and bio-materials
Plastic packaging in the context of development of new materials and biobased materials technology	
Eco-innovations in the new materials and biobased materials technology related to the plastic packaging	• Introduction of the concept of eco-innovations; • Tools for assessment of eco-innovations; • Good practices in eco-innovations

Food packaging materials – regal requirements, properties of materials and their influence on the used for packaging purposes	• Food contact materials in UE legal regulation • Safety of materials intended to come into contact with food • Migration form plastics as mayor risk in plastic packaging materials
Economic and Financial efficiency analysis of the new biomaterials in the plastic packaging industry	• indicators for financial efficiency, their meaning and practical usage for (future) company managers and public administration officers to evaluate the profitability of various • biopackaging materials • indicators for environemntal effects • valuation of environmental effects • cost-benefit analysis
Management tools for implementation of CE for development of plastic packing in the field of new materials and biomaterials	• ReSolve Model -1,5 H • Industrial Symbiosis 1,5 H • Three layer Business Model Canvas
Case study of financial efficiency analysis of the new biomaterials	• students are engaged in the comparative eficiency analysis of chosen materials, • comparison of costs and environmental effects of various waste hadling methods, such as: landfilling or recycling
Analysis and evaluation of packaging materials used for the production of packaging, including for contact with food	• The procedure for assessing the safety of food materials • Analysis and evaluation of selected features and functions of packaging from the perspective of selected entities in the packaging supply chain - case study • Preparation of a declaration of conformity of the packaging material
Selection of appropriate packaging materials to the features and properties of the packed product	• Problems mapping related to solutions in the field of packaging selected groups of goods. • Packaging designing intended for packing specific products (Design Thinking)

2.2. Module 2. Eco-design and Novel Manufacturing Processing

The module will review strategy elements, methods and new production technologies to develop packaging solutions that are easy on the environment and conserve resources. The module is divided into two parts (Table 2).

The first part is focused on selected strategy elements of packaging design for sustainability and on the evaluation of a product environmental impact.

The second part is dedicated to novel manufacturing processing for packaging systems, and will include:

Table 2. Content description for the module Eco-design and Novel Manufacturing Processing

Novel Manufacturing Processing for Packaging Systems (3 ECTS)	
Production processes for flexible plastic packaging	● Basis of extrusion processes ○ Extrusion process: description and equipment ○ Single screw extrusion process analysis ● Industrial processes for the production of flexible packaging ○ Cast film extrusion *Process description, Processing parameters and instability phenomena analysis* ○ Film blowing *Process description, Processing parameters and instability phenomena analysis* ○ Cast/blown film extrusion comparison ● Film orientation techniques
Production processes for rigid plastic packaging: injection molding, blow molding, foaming	● Injection molding ○ Description of the injection machine ○ Description of the four stages in the cycle: clamping, injection, cooling and ejection stages ○ Processing parameters. Properties and defect analysis of injected items ● Blow molding ○ Description of the different types of the process ○ Extrusion blow molding and injection blow molding ● Thermoforming ● Foaming ○ Description of the foaming process for polymeric materials ○ Blowing agents ○ Chemical and physical blowing agents ○ Foaming process with extrusion and injection molding processes

Technologies for new packaging solutions: nanocomposites, active systems, recycled systems, biopolymers	● Overview of the innovative polymeric systems with potential applications in the development of sustainable food packaging ○ Polymeric nanocomposites ○ Active phases: Oxygen scavengers, Moisture controlling systems and Antimicrobial systems ○ Recycled systems ○ Biopolymers ● Pros' and drawbacks in their use for food packaging applications
Manufacturing processes for new packaging solutions	● Production of multilayer films: applications and techniques ● Co-extrusion technique ○ Description and apparatus. Feed-blocks and dies. ○ Flow instabilities: Surface instabilities and Interfacial instabilities ● Extrusion coating and lamination processes ● Case study: design strategies for biodegradable barrier packaging
Technological requirements of new sustainable packaging solutions	● Analysis of the technological trends for the food packaging in the next future ● Technological requirements of new sustainable packaging solutions ○ Physical-mechanical properties ○ Barrier properties ○ Scavenging properties ○ Antimicrobial properties ○ Sustainability
Novel processing technologies	● Advanced manufacturing processes ○ Microcellular foam injection molding (MuCell) ○ Dynamic mold conditioning (Heat & Cool) ○ Example of new processes for Circular economy approach ● Additive Manufacturing techniques ○ New technologies for rapid prototyping with thermoplastic polymeric materials
Innovation and sustainability in surface treatments	● Surface treating basics ○ Wettability, contact angle, surface energy and surface tension ● Corona treatment ● Plasma treatment ● Coating processes ● Sustainability in surface treatments
Sustainable printing technologies	● Description of the technologies for polymeric film printing ○ Rotogravure printing ○ Flexographic printing ● Printing inks ○ Water based inks ○ The solvent less technology ● Sustainable processing aids for the production of food contact packaging
Industry 4.0 for new production technologies	● Industry 4.0 paradigm and key enabling technologies ● Human-robot interaction in Industry 4.0 ○ Cobot applications: Packaging, palletizing and assembly ● Internet of Things and Big Data Analytics
Packaging Design for Sustainability (2 ECTS)	
Material ECO design	● The importance of materials source ● Maximize material lifetime ● Reduce material complexity

	● Biomaterials in the eco-design approach: design for compostability
Designing for the environment and the law	● Packaging and packaging waste directive: essential requirements ● CEN packaging standard
Production, supply chain management and logistic improvement	● Packaging production maximizing resource efficiency ● Preventing over complexity ● Optimize product flows ● Maximize transport load
Design for minimization	● The correct balance between under-packaging and over-packaging: decrease material usage maintain the right performance ● Primary, secondary and tertiary packaging - the trade-offs ● Complying with the essential requirements
Design for reuse, recycling and recovery	● Adding sustainability to traditional design considerations ● Design for dismantling (reduce packaging complexity) ● Increase product recyclability: cases history
An evaluation of a product environmental impact: Life Cycle Analysis	● What is LCA ● LCA main applications ● LCA methodology ● Software for the analysis
How to perform an LCA	● Goal and scope ● Life Cycle Inventory ● Impact assessment ● Interpretation ● Case history ○ Case1 ○ Case2

2.3. Module 3. Residue management and Valorisation

The module on residue management and valorisation will review the issues related to the end of life of plastic packaging materials. The module is divided into three parts (Table 3).

The first part is focussed on the optimisation of logistics, waste separation and sorting of packaging materials.

The second part is dedicated to recycling systems and novel business models for the second life of residues.

The third part will address the economic, environmental and legislative aspects of plastic waste.

Table 3. Content description for the module Residue management and Valorisation

Logistics & sorting (2 ECTS)	
Introduction to polymer materials and polymer processing	• Polymeric materials • Processing of recycled plastics • Effects of processing on thermoplastics • Need of sorting plastics • Reprocessing of thermoplastic recyclates • Current industry position on plastic production and recycling

Residue management	• Residue management
	  ○ Brief Introduction
	  ○ Methods of managing MSW
	  ○ Material Flows in Municipal Solid Waste
	• Warte collection
	  ○ A logistical challenge
	  ○ Sizing the system
	  ○ Transporting waste
	• Sorting plants
	  ○ Introduction
	  ○ Reception and sorting of materials operations
	  ○ Quality control, material adaptation and rejected waste operations
	  ○ Different European Models

Recycling Systems & novel business models for the second life of residues. (2 ECTS)	

Optimization of plastics recycling	• Optimization of plastics recycling
	  ○ Collection
	  ○ Cleaning of plastics
	  ○ Size reduction

Mechanical recycling of packaging waste	• Mechanical recycling • Manual sorting • Manual sorting with a degree of automatization • Automatic sorting tecniques • Flotation tanks • Hydrocyclones • Air classifier • Ballistic separator • Magnetic and eddy current separation • Electrostatic separation • Selective dissolution • Sorting by melting
Secondary plastic products. Examples and market trends	• State of the art • Case examples. • Future market trends.

Chemical routes for recycling. Dissolving, catalytic, and thermochemical technologies	• Depolymerization and leaching
	• Thermochemical processes
	  ○ Gasification
	  ○ Hidrogenation
	  ○ Pyrolysis
	  ○ Reduction in a blast furnace
	• Energy Recovery

Economic, environmental and legislative aspects of plastic waste. (1 ECTS)	
Economic analysis of plastic waste handling	• Costs of recovery • Costs of reprocessing and market forces
Environmental analysis of plastic waste handling	• Mechanical Recycling • Chemical Recycling • Incineration • Landfill
European Union's plastic strategy	• European Union's plastic strategy

2.4. Module 4. Citizen and consumer engagement

This module considers the engagement of the consumers of plastic packaging and more broadly citizens as actors for ensuring a circular development. In the module, the topics of communication, interaction, and engagement of plastic packaging circularity is discussed on different levels. The module is divided in two parts (Table 4).

The first part is focussed on citizen engagement. It identifies end-users as members of society whose circular behaviour is impacted by laws, regulations, and policies, and whose engagement may be linked to, for instance, civil activism.

The second part is focussed on consumer engagement. It identifies end-users as actors in businesses whose behaviour companies try to impact e.g. with different communication and engagement strategies.

Table 4. Content description for the module Citizen and Consumer engagement

Citizen Engagement (2 ECTS)	
Circular economy in a society	• The principle of CE and the phases of CE in a society • The relationship of CE and society • The societal support of CE and benefits of CE for the society
Theory of citizen engagement	• Principles of citizen engagement • Methods of citizen engagement • Principles of communication with citizens
Interacting and engaging citizens in CE	• Case studies of citizen engagement in a CE • Planning and assessing the impact of communication and citizen engagement campaigns
Consumer Communications and Engagement on Plastics Packaging Circularity (3 ECTS)	
Consumer Behaviour and Circularity	• Identification of different kinds of consumers and analysis of the change of consumer behaviour regarding circular plastic packaging. • Consumer behaviour change in circularity in comparison to end-of-life consumption • Consumer behaviour in the context of the CE and plastics packaging • Challenges of consumer behaviour field regarding plastics packaging circularity
Consumer communication and engagement	• Critical evaluation of circular communication and engagement activities targeted to the consumers of plastic packaging. • Pitfalls of consumer communications, such as greenwashing and misleading labels

	• Guidelines for a good practice to inform the consumers about sustainability of a product • Strategies to communicate sustainability to consumers
Value Creation and Circularity	• Basic concept of value creation: business modelling, value creation, value co-creation, customer value proposition • Difference of customer value proposition in single-use economy and circularity • Plastic packaging value chain in circularity • Insights in consumer value creation in the plastic packaging sector
Consumer Engagement	• Defining consumer segments in the plastic packaging industry • Consumer centred approach for understanding consumers
Innovation project	• Innovate consumer engagement activities for circular plastic packaging • Service and customer design principles • Design for behaviour change and consumer engagement

2.5. Module 5. CHAINs

Part of PackAlliance Postgraduate Programme, a novel challenge-based training methodology, called CHAINS, will be developed in order to put in practice competence and skills acquired along the training programme. This specific mechanism will focus on equipping students with transversal skills (particularly those related to creativity, innovation and digital skills) by establishing working teams at the PackAlliance Hubs All students of the postgraduate course will be grouped into CHAINS which will be collaborative teams of students to work on the specific industry challenge during 2 months.

The challenges developed on the CHAINs was established by the Partners in the R3.3 – List of challenges for collaborative projects

List of Annexes:

- Annex 1 – New materials and bio-based materials in plastic packaging sector in the context of development of the CE – Syllabus
- Annex 2 – Plastic packaging in the context of development of new materials and biobased materials technology – Syllabus
- Annex 3 – Novel Manufacturing Processing for Packaging Systems – Syllabus
- Annex 4 – Packaging Design for Sustainability – Syllabus
- Annex 5 – Logistics & sorting – Syllabus
- Annex 6 – Recycling Systems & novel business models for the second life of residues – Syllabus
- Annex 7 – Economic, environmental and legislative aspects of plastic waste – Syllabus
- Annex 8 – Citizen Engagement – Syllabus
- Annex 9 – Consumer Engagement in Plastic Packaging Circularity – Syllabus
- Annex 10 – CHAINs – Syllabus

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