



## Circular Economy Skills Needed in the Plastics Packaging Industry

R2.2 – Survey, Interviews and Workshops with Plastics Packaging Industry Representatives

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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 short name	
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 - Univeristà degli Studi di Salerno (Italy)

## TABLE OF CONTENTS

Circular Economy Skills Needed in the Plastics Packaging Industry	1
R2.2 – Survey, Interviews and Workshops with Plastics Packaging Industry Representatives	1
Document Status	2
Glossary of terms, abbreviations and acronyms	3
1. Introduction	6
2. Study with Plastics Packaging Industry Representatives	6
2.1 Method	7
2.2 Participants	7
2.3 Results in the Four Thematic Areas	9
2.3.1 New Materials and Bio-Based Materials	9
2.3.2 Eco-Design and Novel Manufacturing Processing	12
2.3.3 Eco-Marketing and Citizen Interaction	15
2.3.4 Residue Management and Valorisation	17
2.3.5 Country Comparison	19
2.4 Summary of the Study	21
3. Workshop Outcomes in the Four Countries	22
3.1 Workshop Outcomes in Finland	22
3.1.1 SWOT analysis – New Materials and Bio-Based Materials	23
3.1.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing	24
3.1.3 SWOT analysis - Eco-Marketing and Citizen Interaction	25
3.1.4 SWOT analysis - Residue management and valorisation	26
3.1.5 Summary of SWOT analyses and the workshop in Finland	27
3.2 Workshop Outcomes in Italy	28
3.2.1 SWOT analysis – New Materials and Bio-Based Materials	28
3.2.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing	28
3.2.3 SWOT analysis - Eco-Marketing and Citizen Interaction	29
3.2.4 SWOT analysis - Residue management and valorisation	29
3.2.5 Summary of SWOT analyses and the workshop in Italy	30
3.3 Workshop Outcomes in Poland	31

3.3.1 SWOT analysis – New Materials and Bio-Based Materials	31
3.3.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing	32
3.3.3 SWOT analysis - Eco-Marketing and Citizen Interaction	33
3.3.4 SWOT analysis - Residue management and valorisation	34
3.3.5 Summary of SWOT analyses and the workshop in Poland	35
3.4 Workshop Outcomes in Spain	36
3.4.1 SWOT analysis – New Materials and Bio-Based Materials	37
3.4.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing	38
3.4.3 SWOT analysis - Eco-Marketing and Citizen Interaction	39
3.4.4 SWOT analysis - Residue management and valorisation	40
3.4.5 Summary of SWOT analyses and the workshop in Spain	41
3.5 Summary of the workshop results in the four countries	41
4. Discussion	42

## 1. Introduction

The report summarizes the results of the survey, interviews and a workshop conducted among plastic packaging industry experts in the four partner countries of the PackAlliance project. In March and April 2020, over 40 plastics packaging representatives answered a survey regarding the competency needs and skills shortages of packaging professionals in the shift to the circular economy. In April-July, collaborative workshops addressing the same objectives were organized with plastics industry experts and stakeholders in each partner country.

PackAlliance (funded by Erasmus+ Knowledge Alliance programme in 2020-2022) intends to contribute to modernizing 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. This is seen as a key element for the transition to the Circular Economy within the plastic industry.

The survey, interviews and the workshops were part of WP2, where the objective was to analyse the current stage of the plastics industry and gain knowledge from the industry for the development of higher education curricula in the plastics packaging sector. This report introduces Result 2.2 including a) Milestone 2.1: “At least 40 plastics packaging industry representatives interviewed” and b) the workshops in all partners countries. According to the original plan, each partner country was supposed to have a workshop by the end of April. However, only Finland could maintain that schedule. Because of COVID-19, the workshops were postponed in Spain, Poland and Italy, and organized in June 2020.

The report presents the study based on the survey and interviews, and the outcomes of the workshops conducted in Finland, Spain, Poland and Italy. Chapter 2 introduces the methods, participants and the results of the survey and interviews, chapter 3 presents the outcomes of the organized workshops, and chapter 4 draws together and discusses the results of the study and the workshops. As stated in the research consent, the participants’ and their enterprises’ names are not published in the report.

## 2. Study with Plastics Packaging Industry Representatives

This chapter introduces and summarizes the results of the survey and interviews conducted among plastic packaging industry managers and experts in the four partner countries of the PackAlliance project. In March and April 2020, over 40 plastics packaging representatives answered questions regarding the competency needs and skills shortages of packaging professionals in the shift to the circular economy.

## 2.1 Method

The objective of the study was to find out what competency needs and skills shortages regarding the transformation towards the circular economy are recognized by the plastic packaging industry representatives. The questions for the industry representatives were divided into four thematic areas addressed in the PackAlliance project plan: 1) New Materials and Bio-Based Materials, 2) Eco-Design and Novel Manufacturing Processing, 3) Eco-Marketing and Citizen Interaction and 4) Residue Management and Valorisation. The main target groups were managers and experts working in the plastic packaging manufacturing industry. For acquiring knowledge regarding the whole value chain, representatives of some other plastic packaging sectors were also involved.

The questionnaire consisted of four questions in each thematic area in 10 years' timeframe. The first question was a multiple-choice question, including a list of expertise areas from which the participants could select the relevant ones. The second, open question, asked the participants to specify any other significant expertise areas not mentioned in the list. The objective of the second question was to complement the selected expertise areas in the listings and to ensure their relevancy. The third, also open question, asked the participants to evaluate the most significant skills shortages in their business, regarding the shift to the circular economy. The last question gave a free word to the participants.

All the partners in Spain, Poland, Finland, and Italy contributed to the planning and conducting the surveys and interviews. The questionnaire was an eForm built by TAMK, the task leader. All partners were able to make a copy of the form and use either English or their national language with the participants. After conducting the survey and interviews locally, the answers were sent to the main eForm managed by TAMK. The questionnaire was used both for surveys and for interviews. Among 46 responses, 19 interviews were conducted for acquiring some in-depth sights about the topic. In the interviews, the participants answered the survey first. After that, the answers were completed with an interviewer.

All participants were contacted personally before sending the questionnaire to rise their awareness of the PackAlliance project and to motivate them to answer to the questions. In the questionnaire, the participants were asked to evaluate how critical field the circular economy is in their business. With a scale from 1 to 5 stars, the average rating was 4.5 stars.

In general, the contacted experts found the study and PackAlliance project relevant for their business.

## 2.2 Participants

The aim was to reach at least 40 plastic packaging representatives. A total of 46 responses were received from different companies. Overall, 9 responses were from Finland, 13 from Italy, 10 from Poland, 13 from Spain and 1 from France.

Most of the interviewed companies were plastic packaging manufacturing companies, but stakeholders were also interviewed or answered the survey. Participant position in the company is presented in Figure 1. The target group comprised especially of persons who are working in manager and specialist positions. From all participants, approximately 59% are working in these types of positions.

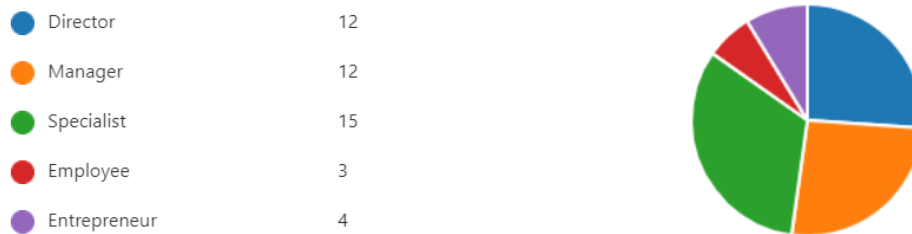


FIGURE 1. Participant position in the company

The position of the participants met the target of the study. Almost 70% out of the interviewed companies employ more than 50 people (Figure 2).

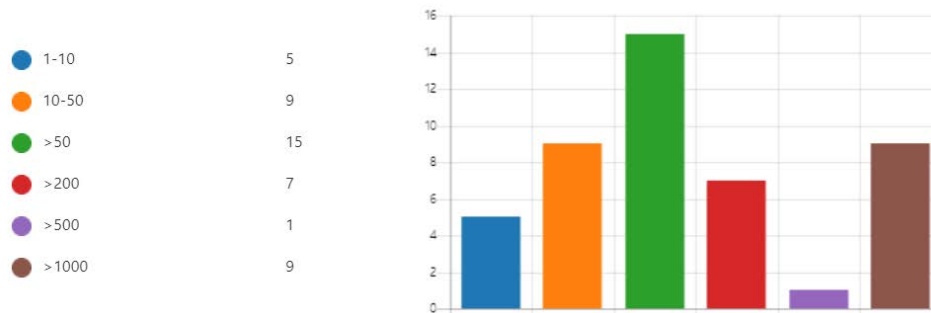


FIGURE 2. Size of company/organisation/institution (number of employees)

Interviewing companies of different sizes and activities, who use different plastic materials in the manufacturing process, provided a broad scope of answers. This provided a good basis to study of the most significant skills shortages and the expertise needed in the future education in transition of the plastics packaging industry to circular economy.

Figure 3 shows the activity sector of the interviewed companies. The food and beverages sector is marked as the largest activity sector 22/65 (34%), and can be considered the most significant sector in the interviews. In the study, a remarkable number 18/65 (28%) of respondents answered “other”. Many of those participants were stakeholders linked to plastics packaging industry.



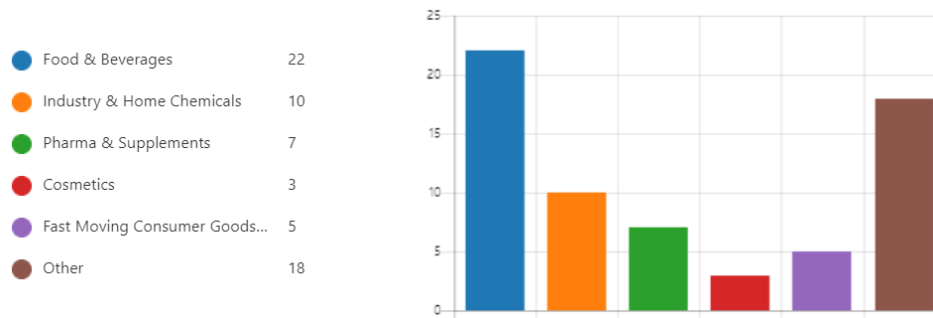


FIGURE 3. Activity sector of the interviewed companies

Figure 4 represents the plastic materials used in the plastic packaging industry, according to these interviews. Based on these results, PET, PE, PP, and multimaterials are the most used by the companies/enterprises interviewed.

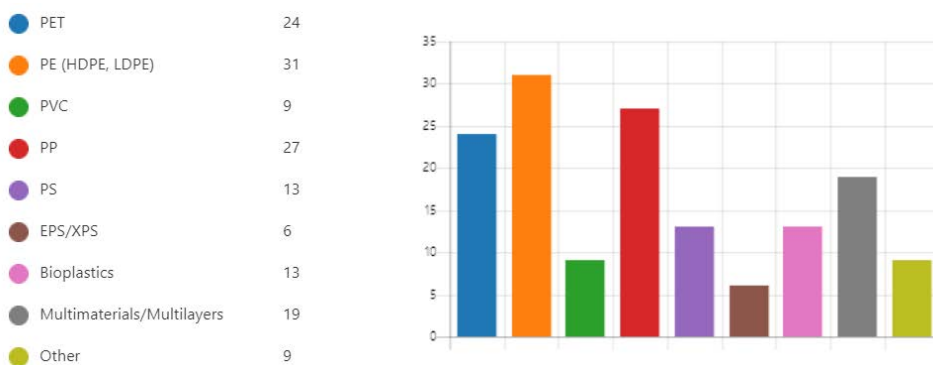


FIGURE 4. Plastic materials used in the interviewed companies

Based on the open answers, the enterprises that used multimaterials focused both on the fiber and plastic solutions.

## 2.3 Results in the Four Thematic Areas

The questionnaire focuses on four thematic areas regarding skills shortages and educational needs in 10 years' timeframe. The thematic areas are: 1) New materials and bio-based materials, 2) Eco-design and novel manufacturing processing, 3) Citizen interaction & eco-marketing, and 4) Residue management and valorisation. These four areas have been identified as crucial for leading transition towards CE within the plastics packaging sector. For the questionnaire, a tentative list of topics belonging to the four respective thematic areas described in the PackAlliance project plan was exploited (Detailed project description, 111).

### 2.3.1 New Materials and Bio-Based Materials

In new materials and bio-based materials, the participants were asked to evaluate the relevancy of the following expertise areas (Figure 5): 1) knowledge characteristics of biomaterials (25%), 2) edge biomaterials pros and cons and feasibility (25%), 3) current and

future situation of the market for biomaterial developments and emerging trends (25%), 4) and new regulations applicable to innovative material (25%).

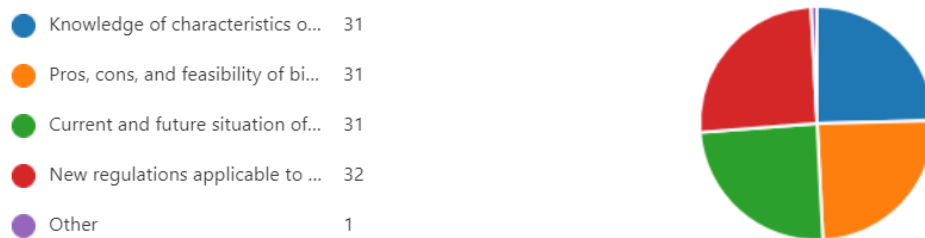


FIGURE 5. Areas of expertise relevant to participants' business in 10 years' timeframe in the field of New Materials and Bio-Based Materials (qty/responses)

Regarding the open question about skills shortages, expertise, and education needed in 10 years' timeframe, the respondents highlighted sustainability and a long lifetime of products: In the future, new materials and sustainability should be considered. The participants expected to see more bio-based and biodegradable solutions to offer for their customers in the near future. One question addressed was how to commercialize innovations. Good ideas are available, but who will be the one to take the first step towards the new materials? It is good to remember that new materials are always linked to the available technology. The variability in terminology used and the lack of normalisation are facts at the moment. Precise legislative regulation in the field of bioplastics is also needed. In the field of new materials, more R&D is needed to produce high quality, homogeneous raw materials, with a reasonable price of ingredients. A balance between costs, sustainability and innovations should be a desirable value. This includes the food safety aspect and a wider perspective in demand of different markets related to new materials.

The skills needed in this field are the understanding of the legal aspects, and a confirmation that professionals understand the big picture of new materials: not only the opportunities but also the limitations of new materials and bio-based materials. In the future, the question of what a sustainable material really is should be addressed. It is crucial for plastic packaging professionals to understand the whole value chain: the producer's, converter's, end-user's, and consumer's needs are essential. This includes, for example, understanding the pricing issues, as the biomaterials are currently expensive, or converting issues, such as the problems the materials may cause. For some of the companies, eco-design means minimizing the usage of plastics, and bio-based materials can be a solution for this in the future.

Figure 6 presents the key themes raised by the participants in their qualitative, open responses. Since it is compiled from qualitative data, the figure does not provide exact quantification of how many times or how many participants took a particular theme under discussion. The function of the slices of the chart is to roughly indicate the occurrence of those themes in the data.

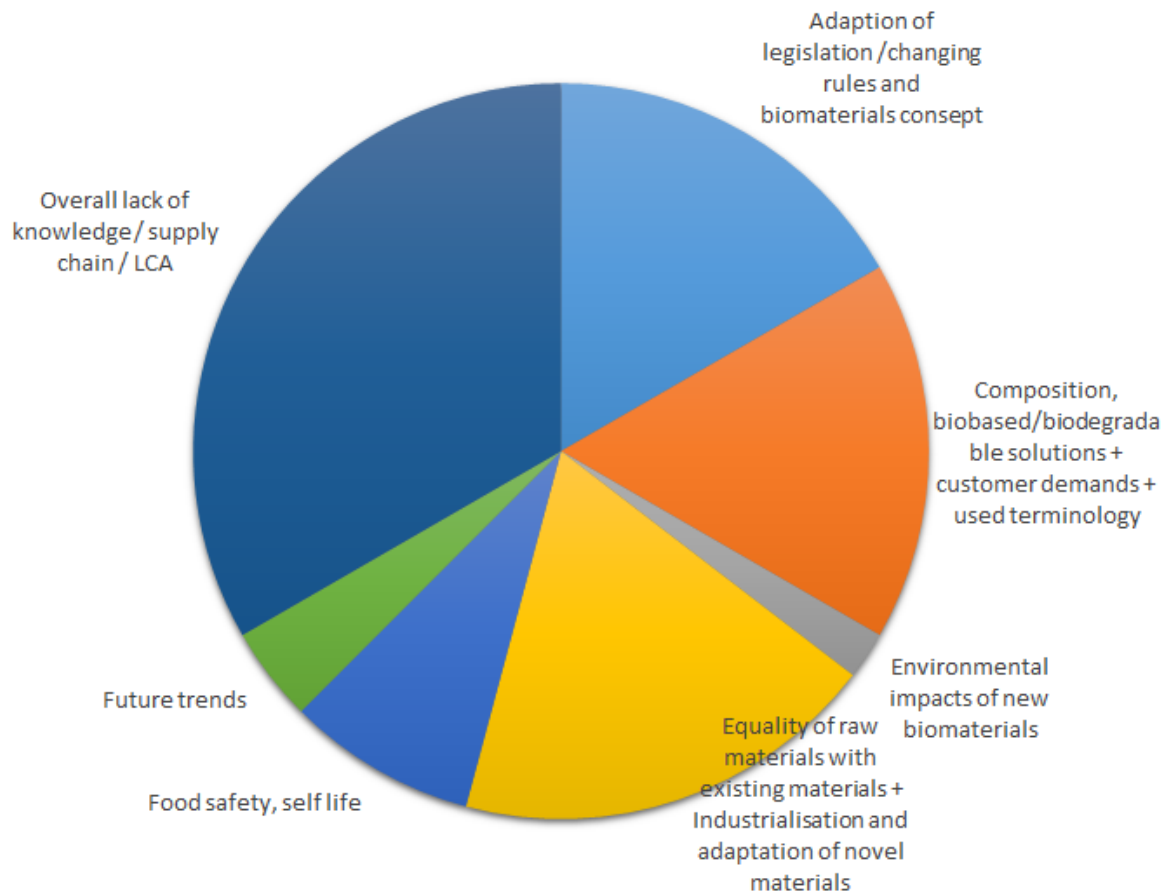


FIGURE 6. Skills shortages and expertise needed in the field of New Materials and Bio-based Materials, according to the open responses.

**Examples of open answers regarding skills shortages and educational needs:**

“Chemical expertise and knowledge on composition of new raw materials (bio-based, biodegradable,...) Better knowledge of strengths and weaknesses of polymers with reference to all possible applications including food packaging.”

“Deep knowledge of actual standard structures and how-to replace them with new materials.”

“Characteristics of novel materials compared to those currently available. Industrial implementation of novel materials. Demand of different markets related to new materials and biomaterials.”

“Lack of normalisation and regulation on novel materials. Lack of expertise held by professionals. Tarification by regulatory agencies is similar to that of other plastics.”

“Legal aspects. Eco-design. Life cycle assessment. In-depth studies for all materials. Regulatory framework.”

“Fact based (LCA) understanding of different Packaging material solutions in order to make reasonable decisions from environmental point of view.”

### 2.3.2 Eco-Design and Novel Manufacturing Processing

In the thematic area of eco-design and novel manufacturing processing, participants were asked to evaluate the relevancy of the following expertise areas. (Figure 7): 1) product protection (e.g. shelf life) (app. 12% from the participants), 2) technologies and techniques to minimise pollutants (10%), 3) applying needs-based packaging size (4%), 4) optimising packaging weight and volume (10%), 5) use of recycled material and bio-based materials (16%), 6) mindful product design (Anti-littering, recycling, etc.) (13%), 7) KPI indicators monitoring and assessment (6%), 8) newest manufacturing processes for low energy and pollutants production (10%), 9) new plastic-based materials processes (8%), 10) biomaterials manufacturing techniques (3%), 11) new industry 4.0 applications (6%), 12) IoT and sensing (2%).

Product protection (e.g. shelf l...	30
Technologies and techniques t...	24
Applying needs-based packag...	9
Optimising packaging weight ...	25
Use of recycled material and b...	38
Mindful product design (Anti-l...	32
KPI indicators monitoring and ...	14
Newest manufacturing proces...	25
New plastic-based materials p...	20
Biomaterials manufacturing te...	7
New industry 4.0 applications	15
IoT and sensing	4
Other	2

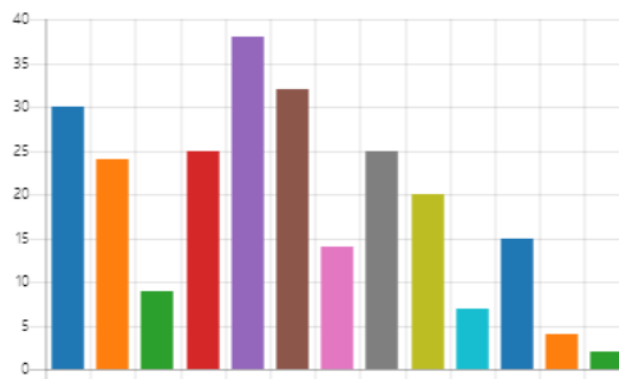


FIGURE 7. Areas of expertise relevant to participants business in 10 years' timeframe in the field of Eco-Design and Novel Manufacturing Processing (qty/response)

Regarding the open question about skills shortages and educational needs, the participants see these two areas eco-design and novel manufacturing processing separate from each other. On the other hand, these two fields should be aligned and overall understanding is needed. For example, it is possible to improve the packaging eco-design by improving the manufacturing process.

Figure 8 presents the key themes raised by the participants in their open responses. The slices of the chart indicate the occurrence of those themes in the data.

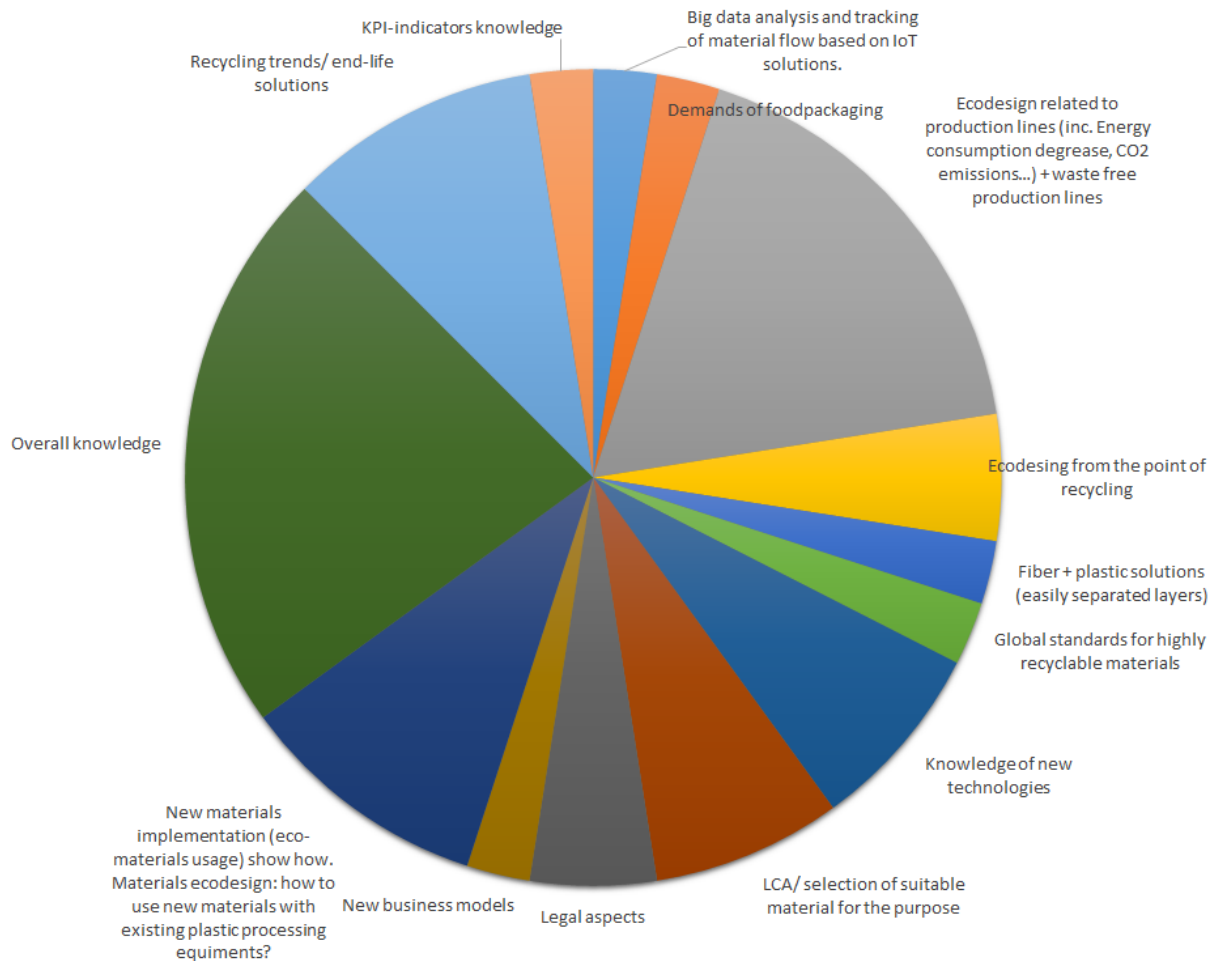


FIGURE 8. Skills shortages and expertise needed in the field of Eco-design and Novel Manufacturing Processing, according to the open responses.

### Eco-design

Regarding the open question about skills shortages, expertise, and education needed in 10 years' timeframe, the participants found, for example, applying needs-based packaging size and optimising packaging weight and volume as important topics to cover. These are topics, which are already quite well handled. They are, or they should be, normal packaging design perspectives in the companies. In the future, companies should focus more on the materials they use.

Examples of open answers regarding skills shortages and educational needs:

“On the material side, eco-design is such a freak that it can be a bit of anything. It depends on the viewing position. The use of bio-based or recycled materials is not a

problem in itself - the testing process follows the same path as traditional materials. Things always stop for rising costs or the fact that the technical properties are not at the same level than the virgin material. It is important to invest in the recycling process and know-how in this field. The better the goods are recycled, the better the downstream products can be processed. In terms of eco-design, all the things that reduce the basic grammage weight and just the right package size, the solutions that consume as little raw material as possible, are well controlled. This has been done for a really long time. Then again, in the raw material side when thinking and talking about eco-design we talk about the following terms, for example: bio-based or biodegradable? Ecodesign with raw material often means often costs. The customer wants to be “eco” but when we start talking about price, the desire is no longer so strong. The same thing is faced on the development side of production, often production challenges mean rising costs.”

“Eco design is also things like, how we can improve our production lines by investments. For example, how to decrease energy consumption, CO2 emissions etc. Things related to ISO 14001. In addition, these kinds of things can be related to eco-design and value offering. In fiber + plastic solutions, customer requirements are quite often on how to minimize plastics or get rid of it totally. Biodegradable and bio-based solutions could help in this.”

“Big data analysis and tracking of material flow based on IoT solutions.”

### **Novel manufacturing processing**

Regarding the open question about skills shortages, expertise, and education needed in 10 years' timeframe, the participants emphasized, for example, that technology investments are very expensive. The knowledge of improving existing technology should be taken seriously. The topics rated with high scores among the respondents were the newest manufacturing processes for low energy and pollutants production, and technologies and techniques to minimise pollutants.

### **Examples of open answers regarding skills shortages and educational needs:**

“Technologies and techniques to minimise the presence of contaminants.”

“Regarding eco-design, the company strategy is based on developing sustainable materials that can be processed with existing plastic processing equipment. It enables feasible transition from traditional plastics to biodegradable materials with minimal investments for the converters. In addition, the end-of-life scenarios as well as avoiding micro-plastic generation are highly important for the company. In the future education, understanding the full benefits of biodegradable materials is needed.”

“Knowledge of the latest production processes with low energy consumption and the production of waste”.

“Knowledge about waste-free production, in which virtually anything can be reused without generating waste.”

### 2.3.3 Eco-Marketing and Citizen Interaction

In eco-marketing and citizen interaction, the participants were asked to evaluate the relevancy of four expertise areas: 1) new business models related to eco-packaging (26%), 2) eco-marketing campaigning (23%), 3) promotional strategies for return systems for both single use and reusable packaging (25%), and 4) anti-littering campaigns and citizen active participation (26%). As can be seen from figure 9, the different expertise areas gained the same level of support from the participants. There were no suggestions for other expertise areas to be listed.

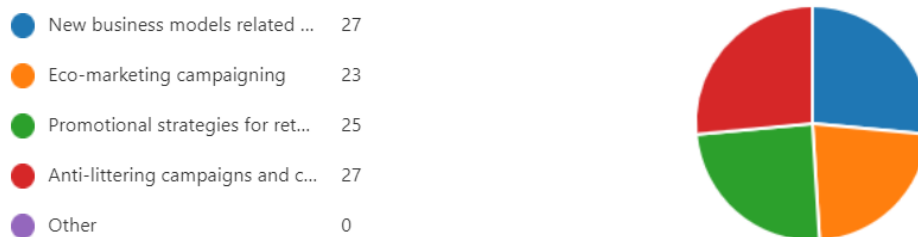


FIGURE 9. Areas of expertise relevant to participants business in 10 years' timeframe in the field of Eco-Marketing and Citizen Interaction (qty/responses)

Regarding the open question about skills shortages and expertise and education needed in 10 years' timeframe, the participants highlighted a communication gap between the plastic packaging industry and consumers/citizens. The professionals should have competences to translate scientific and industry-specific terms and language to consumers. Marketing skills and understanding of consumer behaviour were also mentioned. The participants emphasized the ability to communicate fact-based information to citizens, which includes a responsible attitude in order to avoid greenwashing, and providing materials, from which consumers can create their critical opinion. Information campaigns, e.g. for recycling plastics (either conducted in-house or with a trusted marketing company), were seen as a relevant activity in companies and, thus, an expertise area for higher education. However, it was noted, that as long as there are no common guidelines about terms, politics, and eco-design principles in the industry and society, communication and interaction with citizens is challenging. Therefore, improving citizen interaction in the circular economy requires changes in the whole value chain and a holistic understanding of that value chain, including the development of recycling and sorting technologies.

Figure 10 presents the key themes raised by the participants in their open responses. The slices of the chart indicate the occurrence of those themes in the data.



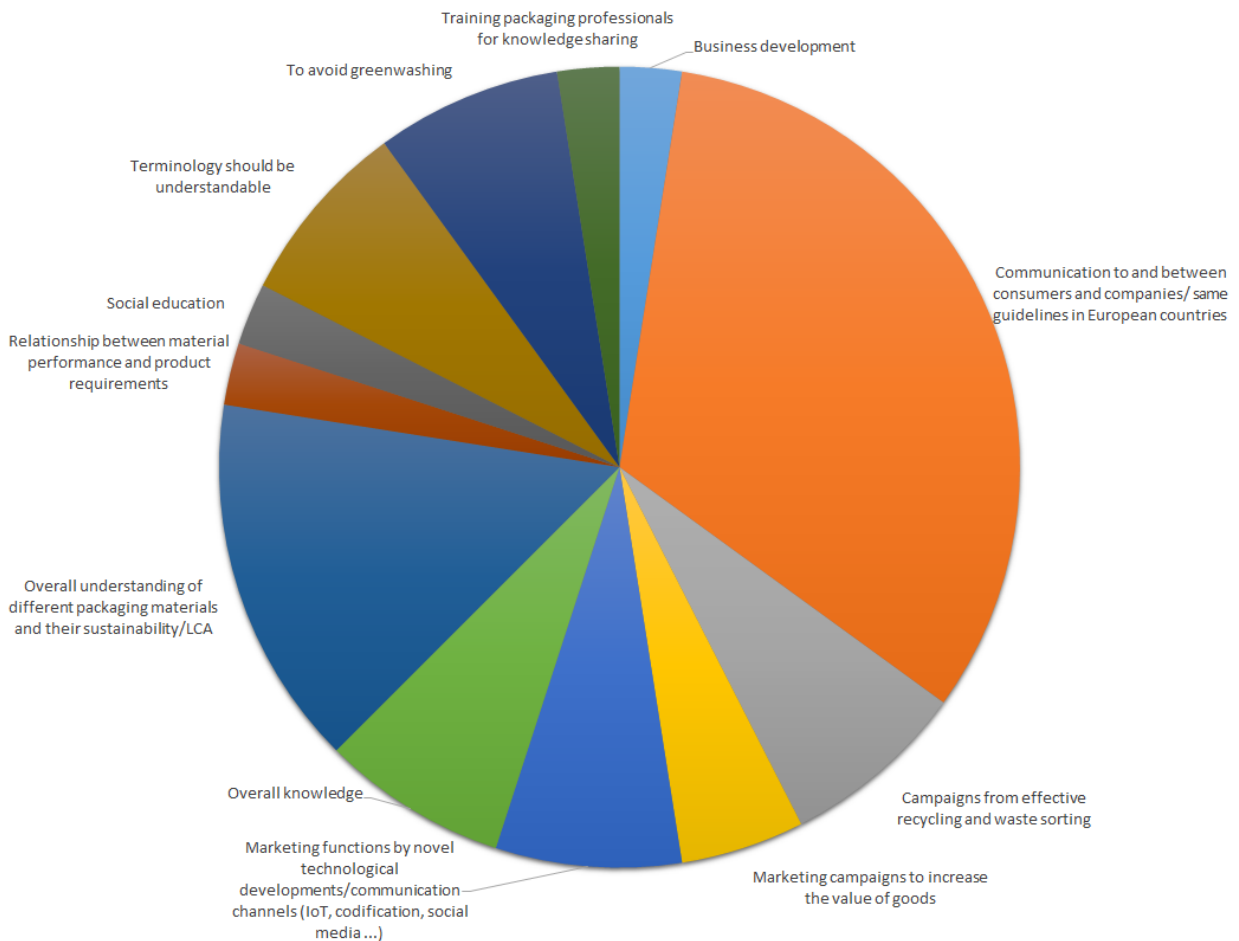


FIGURE 10. Skills shortages and expertise needed in the field of Eco-Marketing and Citizen Interaction, according to the open responses.

**Examples of open answers regarding skills shortages and educational needs:**

“The main problem is the lack of uniformity of recycling guidelines in various countries. As already mentioned, it’s difficult to plan eco-marketing campaigns or improve citizen interaction if we can’t have a clear vision of the guidelines for eco-design.”

“Knowledge of markets to work and increase consumer awareness on responsible consumption. Training on the standardisation of messages to properly communicate true and valuable environmental information.”

“Competencies are needed in how to communicate scientific data in a comprehensible way.”

“Clear information. There is a lot of greenwashing and consumers do not have knowledge to build up a critical opinion.”



“Biggest skills shortage: Lack of an information campaign on the environmental impacts of products. Expertise and education: development of training courses and application of methodologies capable of calculating the environmental impact of company processes and products.”

### 2.3.4 Residue Management and Valorisation

In residue management and valorisation, the participants were asked to evaluate the relevancy of following expertise areas: 1) methods to improve sorting and recycling system (29%), 2) optimisation and resource-efficient logistics (14%), 3) waste prevention along the supply chain (24%), 4) open data generation and sharing (12%) and 4) novel business models for the second life of residues (21%). According to the answers, the most relevant area is sorting and recycling development (Figure 11). Waste prevention and business model development were also considered important. The areas 2 and 4 were less selected, but still by a relevant number of participants. The participants did not suggest any other fields of expertise for this thematic area.

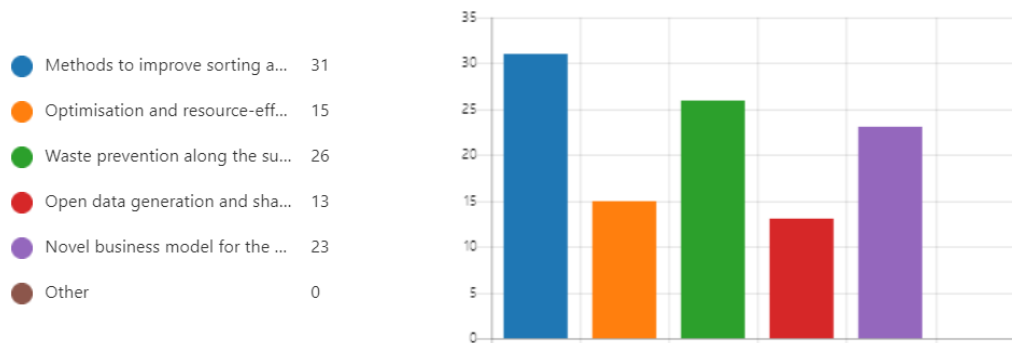


FIGURE 11. Areas of expertise relevant to participants' business in 10 years' timeframe in the field of Residue Management and Valorisation (qty/responses)

According to the answers to the open question about skills shortages and expertise and education needed in 10 years' timeframe, the plastic packaging industry lacks information sharing and openness, which would be needed to develop common knowledge and standards for sorting and recycling. Information sharing should happen between different companies and stakeholders and cover all parts of the value chain. The respondents mentioned waste management as one expertise area with skills shortages, which would especially need a holistic understanding of the plastic packaging value chain. New recycling technologies, e.g., chemical recycling, were seen as an important competence area that has not evolved in a sufficient manner, along with material development, which may hinder innovative material development and business models.

Figure 12 presents the key themes raised by the participants in their open responses. The slices of the chart indicate the occurrence of those themes in the data.

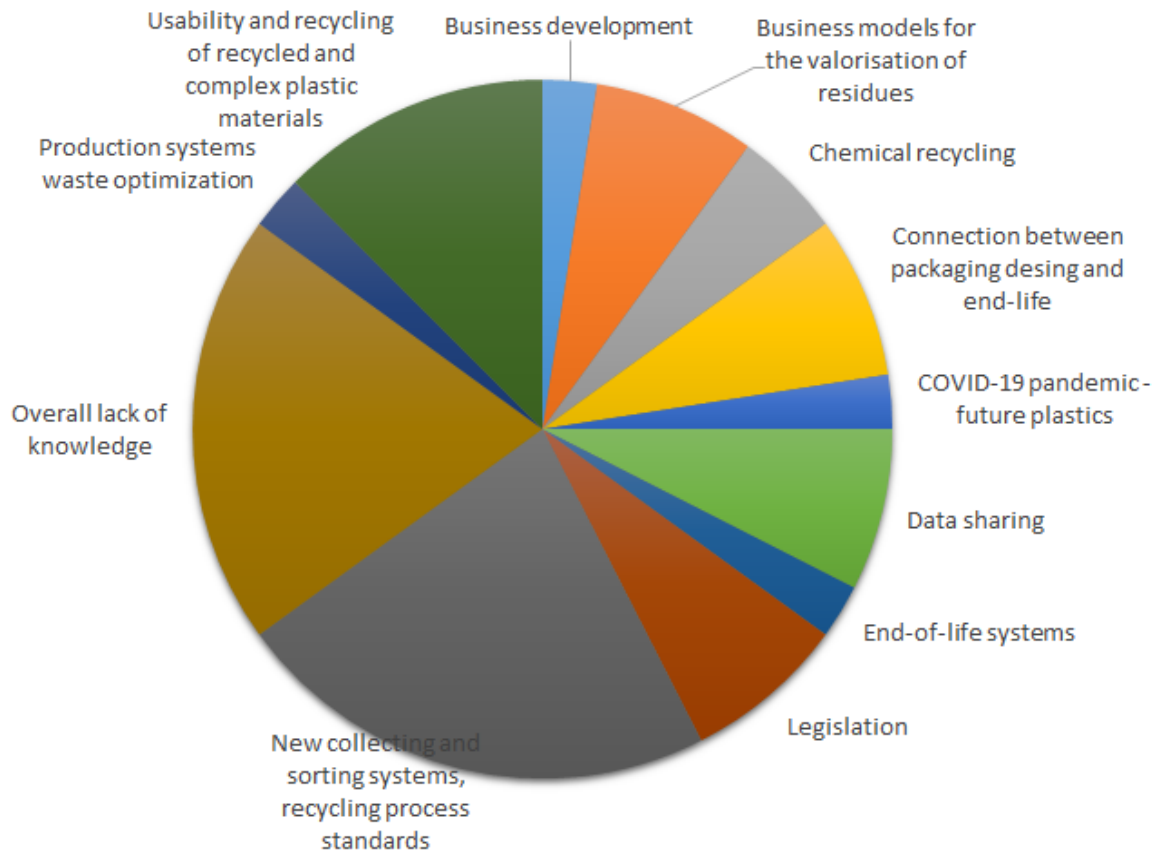


FIGURE 12. Skills shortages and expertise needed in the field of Residue Management and Valorisation, according to the open responses.

**Examples of open answers regarding skills shortages and educational needs:**

“Currently, recyclability has been the main driver in new legislation and novel packaging solutions. However, the definition of recycling should leave the door open for new recycling technologies, such as the different forms of chemical recycling. Europe will lose its power to innovate new sustainable materials if the market entry is dictated solely by the status quo of the current recycling infrastructure. The role of organic recycling of packaging materials should be recognized and its role in EPR schemes enabled, clarified and justified. Infrastructure of separate biowaste collection should also be utilized in the organic recycling of compostable packaging. Expertise, education and collaboration along the whole value chain from material innovators to waste management sector should be increased and the infrastructure developed and aligned with existing or upcoming standards.”

“Biggest skills shortage: sharing data between the various company departments. Expertise and education: new business models of interaction and sharing.”

“Lack of knowledge. Currently, businesses hire the services of other companies that have the expertise to manage issues at the end of the chain. However, if we were able to integrate knowledge from the beginning (providers) we would be able to optimize, minimise generation and improve subsequent valorisation.”

### 2.3.5 Country Comparison

Differences between the partner countries were explored by comparing the multiple-choice responses. In the thematic area of "New Materials and Bio-Based Materials", the division of responses was similar to the common results shown in figure 5. Although there were some variations in the other thematic areas, they were not clear enough to indicate differences between countries when taking into account some other possible parameters, such as the industrial sector or a type of company of a participant. The following figures (13-16) present the country-specific results of the thematic area, "Eco-Design and Novel Manufacturing Processing".

#### Spain

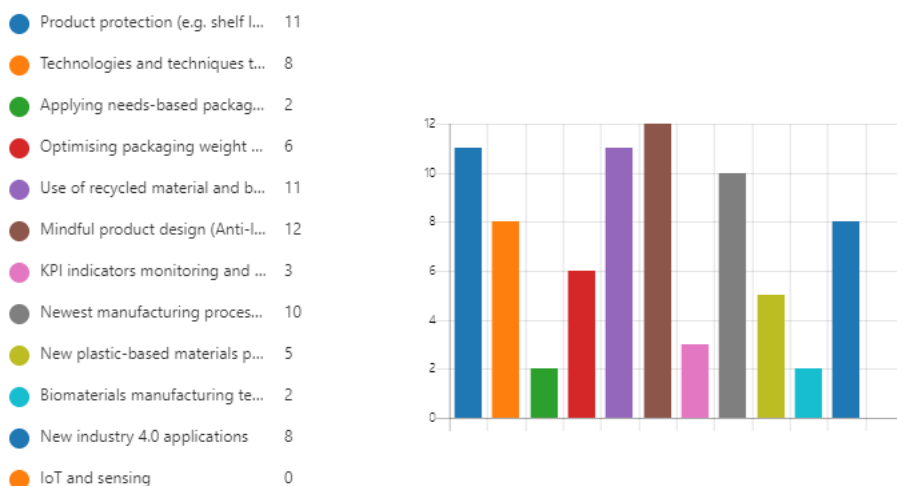


FIGURE 13. Areas of expertise relevant to participants' business in 10 years' timeframe in the field of Eco-Design and Novel Manufacturing Processing (qty/response) in Spain.

## Poland

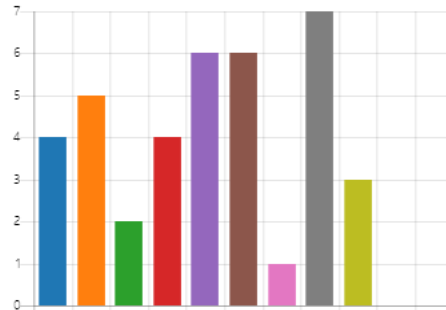
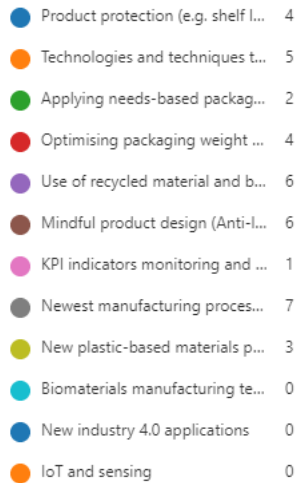


FIGURE 14. Areas of expertise relevant to participants business in 10 years' timeframe in the field of Eco-Design and Novel Manufacturing Processing (qty/response) in Poland.

## Finland

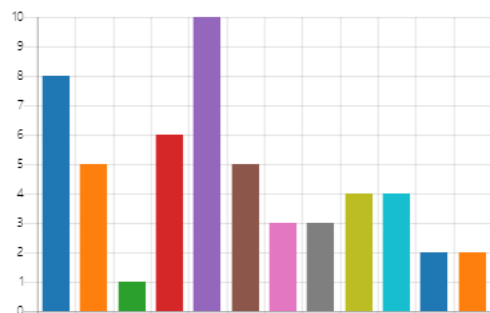
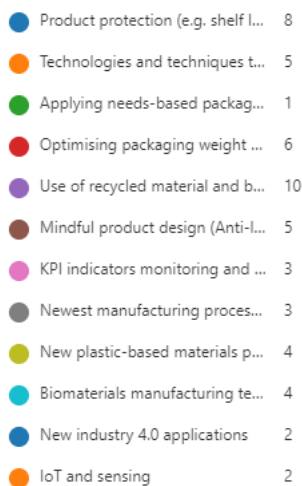


FIGURE 15. Areas of expertise relevant to participants business in 10 years' timeframe in the field of Eco-Design and Novel Manufacturing Processing (qty/response) in Finland.

## Italy

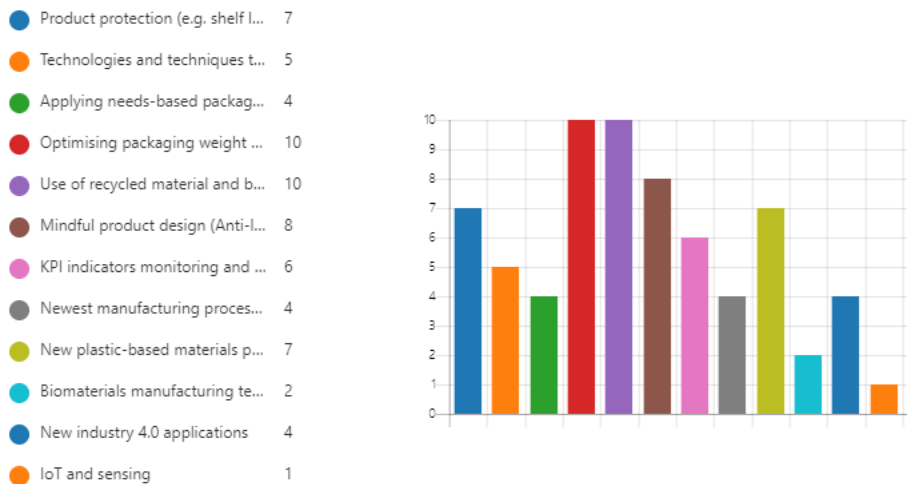


FIGURE 16. Areas of expertise relevant to participants business in 10 years' timeframe in the field of Eco-Design and Novel Manufacturing Processing (qty/response) in Italy.

As can be seen from the figures, there are some expertise areas commonly emphasised (e.g., Use of recycled material and bio-based materials) or given less notice (e.g., IoT and sensing). Although the reasons for the differences shown in the figures may be something other than the participant's country, the differences may be worth discussing between the partners while developing competency profiles for the plastic packaging professionals in the PackAlliance project. For example, a low bar of some expertise field does not automatically mean that the field is not relevant. It may also indicate an area that is not sufficiently taken into account, or alternatively, is already well-managed in the industry.

## 2.4 Summary of the Study

The quantitative objective of the Milestone 2.1 "At least 40 plastics packaging industry representatives interviewed" was achieved with 46 responses collected on the eForm. The responses divided by country as follows: Spain 13, Poland 10, Finland 9, Italy 13, and France 1.

The survey questions and eForm were prepared together with the universities and the companies of the consortium. While conducting the survey and interviews, each packaging industry representative was contacted personally. This may be one reason for their high motivation to participate in the study. Consequently, the objectives of PackAlliance project were seen as very important for the plastic packaging industry.

Based on the results, the thematic areas and the respective expertise fields addressed in the PackAlliance project plan are relevant for the industry. In the last "open word" part of the survey, a participant raised a topic, which was not covered by the free-choice or open questions, namely the reusable packaging trend regarding the reuse of bottles. The reusability of the packaging has a connection to all four thematic areas, and it should be considered at

least in Eco-Design and Novel Manufacturing Processing and Residue management and valorisation. Understanding of LCA (life-cycle assessment) is crucial. One should be able to evaluate whether using a bottle several times is a sufficient quality indicator for the recycling process. This is an example of how systemic thinking and understanding of the whole value chain is a requirement when analyzing skills shortages of plastics packaging professionals.

The survey reached well the main target groups: managers and experts in the plastic packaging manufacturing industry. However, involving other stakeholders as well was a valuable choice, because understanding the whole value chain was seen highly important. According to the participants, the shift to the circular economy requires open information sharing and collaboration of all contributors in the plastic packaging value chain. For example, companies who operate in recycling and sorting business should understand better the needs of material developers and manufacturers. In addition, for the purposes of sustainable recycling and sorting, all companies should know how to work and communicate with citizens.

### 3. Workshop Outcomes in the Four Countries

As part of WP2 (Detailed project description, 106), four national workshops were to be organised in each participating country (Spain, Poland, Finland, Italy) to bring together local stakeholders for analysis and discussion. The partners planned to conduct the workshops by the end of April. However, due to COVID-19, Spain, Poland, and Italy had to postpone their events that were organised in June and July 2020.

#### 3.1 Workshop Outcomes in Finland

A national workshop in Finland was organised to bring together local stakeholders in order to analyse and discuss the competency development and training solutions, which should be enhanced by HEIs in the shift to the circular economy in the plastics packaging industry. Altogether 15 professionals from the packaging industry and stakeholder organisations attended the event. The participants represented the top actors in the industry and stakeholders connected to plastics packaging. With hosts (PackAlliance partners TAMK and Pyroll), the number of the participants was 23. The two-hour workshop was organized online because of COVID-19.

The workshop aimed to promote networking and create new ideas for co-operation between the participants. The workshop consisted of three parts: PackAll introduction, two short industry presentations, and facilitated teamwork. The participants were divided into four multidisciplinary teams (4-5 participants/team) according to the four thematic areas of PackAlliance project: 1) New materials and biomaterials, 2) Eco-design and novel manufacturing processing, 3) Citizen interaction & eco-marketing and 4) Residue management and valorisation.

Each team's task was to build a SWOT analysis of the most relevant knowledge and skills of packaging professionals in 10 years' timeframe in the respective thematic field. Table 1 shows

the general setting of the analysis task, including the questions for the SWOT analysis. After the teamwork, the outcomes were discussed with all participants of the workshop. At that stage, results were supplemented by comments raised in this general discussion.

TABLE 1. General setting of the SWOT analysis teamwork task in Finland.

What are the most important knowledge, skills, and training needed in 10 years' timeframe?	
<b>STRENGTHS</b> What assets and skills can professionals bring to this field already? What do you find appealing?	<b>WEAKNESSES</b> List any competency deficits you think professionals have in this field. Biggest skills shortage/s in packaging business?
<b>OPPORTUNITIES</b> Assess market climate. List any external factors benefiting circular economy. List doors that are currently open.	<b>THREATS</b> List any hazards of entering this field

Next, the outcomes of the teamwork in four thematic focus areas and their summary are presented as SWOT analyses. The SWOT analyses were built by brainstorming, where collaborators raised topics that they found relevant regarding the theme. The following chapters show the results of the teamwork. The workshop was conducted in Finnish, and the outcomes were translated into English.

### 3.1.1 SWOT analysis – New Materials and Bio-Based Materials

TABLE 2. SWOT analysis results regarding New materials and bio-based materials in Finland.

<b>STRENGTHS</b> <ul style="list-style-type: none"> <li>Increasing student awareness and understanding</li> <li>What is possible, based on the existence and understanding of different plastic grades.</li> </ul>	<b>WEAKNESSES</b> <ul style="list-style-type: none"> <li>Understanding the whole supply chain, and value chain</li> <li>Definitions and terms need to be clear (e.g., for biomaterials, the definition of terms is still ongoing)</li> <li>Meaning and methods of LCA (Life-Cycle Assessment). LCA analyses should be further developed, and it should be understood that different analyses cannot be compared with each other (analysis for the whole product). Among other things, microplastics emissions and litter are missing from analyses so far, and there are different criteria for bio-based and for "traditional plastics"</li> </ul>
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	<ul style="list-style-type: none"> <li>• Future technologies should be kept in mind (e.g., recycling).</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>• Commercial exploitation and availability of biomaterials?</li> <li>• In higher education, exact up-to-date education is important!</li> <li>• Innovations for plastic reuse: Now recycled plastic remains unused without new applications utilising it, e.g., the re-use of other plastics than just PET plastics in food packaging. Biomaterials?</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>• The whole supply chain is not considered</li> <li>• Is LCA widely understood in biomaterials as well? - instructions for the user must be clearly available</li> <li>• New materials must be recyclable/compostable.</li> </ul>

### 3.1.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing

TABLE 3. SWOT analysis results regarding Eco-design and novel manufacturing processing in Finland.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>• Knowledge of customer functions: what happens 'in the field', suppliers</li> <li>• Benchmarking: cooperation, international networks</li> <li>• Sustainability</li> <li>• Important thematic area.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>• Already made investments might be a limitation: used technology, existing production lines</li> <li>• The manufacturer must have knowledge and patience</li> <li>• Ecological perspective: what is that? Need to find out!</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>• Cooperation: a lot of potential!</li> <li>• Direct contacts: communicating directly with retailers and, through them, with consumers</li> <li>• Educational opportunities: What is the need for food packaging? e.g. bioplastics</li> <li>• Training companies' organization, e.g., terminology (LCA, bioplastics, etc.) = lifelong learning</li> <li>• What happens to the packaging after the consumer has bought it? Training needed</li> <li>• Regulation: What are the rules and legislation (e.g., what does recyclability mean?)</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>• Risk of costly misinvestments</li> <li>• Lack of knowledge regarding political decision making</li> <li>• Unclear communication regarding political decision making</li> </ul> <p>Political decision-making must be involved, and clarity of communication is needed to avoid adverse decisions to the environment. There is a risk of misinvestments, which might cause costs. Decisions made today are no longer in line with sustainable development in the future. Professionals need more knowledge to tackle these types of threats.</p>



<ul style="list-style-type: none"> <li>• Responsibility: Establish clear instructions on how to recycle packaging.</li> </ul>	
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### 3.1.3 SWOT analysis - Eco-Marketing and Citizen Interaction

TABLE 4. SWOT analysis results regarding Eco-marketing and citizen interaction in Finland.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>• Strong “substance” knowledge.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>• A basic consumer is lost. Packaging labels are difficult to understand (cannot recycle). Too many options for consumers, what numbers to put in which recycling boxes. New solutions are needed. Consumers do not know what composting labels mean. Numbering should be completely rethought based on recycling</li> <li>• Everyone is an expert in their own field, but the terms are not common and clear even among the packaging industry representatives</li> <li>• From raw materials to consumers: understanding the whole supply and value chain</li> <li>• Expertise in the field of CE needed</li> <li>• Collaborative expertise where information is shared is needed</li> <li>• Packaging solutions need to be usable for consumers: For example, industrial composting, bioplastic bags get stuck in the equipment.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>• Recycling tricks/opportunities for consumers (reuse of packaging as such, e.g., yoghurt pots as drinking cups)</li> <li>• Brands have increased guidance, but EU legislation would be needed</li> <li>• Finding common terms and rules</li> <li>• Increasing importance and awareness of recycling for consumers: What innovations include it? (Instead of traditional recycling labels)? How can we affect consumer behaviour?</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>• The media does not share the right information, or it confuses terms</li> <li>• A large pile of traditional plastics that cannot be recycled</li> <li>• Is it not understood that recycling is not synonymous with sorting (even if a consumer recognizes material as plastic and sorts it into recycling, it does not necessarily mean the plastic will be recycled).</li> </ul>

<ul style="list-style-type: none"> <li>The whole education system, from childhood to higher education, would need a significant increase in the contents of CE and plastics packaging.</li> </ul>	
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### 3.1.4 SWOT analysis - Residue management and valorisation

TABLE 5. SWOT analysis results regarding Residue management and valorisation in Finland.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>Significant players in Finland related to recycled plastics</li> <li>The general atmosphere is positive about recycling</li> <li>Expertise in the field of raw materials</li> <li>The usage of recycled plastics</li> <li>Atmosphere is conducive for innovations.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>Understanding of regulative legislation from a company point of view</li> <li>Recycling technologies need to be developed to fit for new materials (and to support material innovation)</li> <li>Recycling methods development needed.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>Chemical recycling: closed loop, food packaging, e.g., PET. Update of legislation on the use of recycled plastics in food packaging (EFSA approval)</li> <li>Packaging design: usage of monomaterials</li> <li>Companies' internal communications/supply chains</li> <li>Not necessarily product only, but also other requirements as part of the process (2<sup>nd</sup> life solutions for packaging, how to reuse before recycling)</li> <li>The value chain thinking</li> <li>Multidisciplinary thinking</li> <li>Ease of recyclability: Intelligent packaging solutions and sensors at the recycling plant (investments are needed). QR codes already in use</li> <li>Reinforcing the reuse of plastic packaging</li> <li>What is recycling in the future?</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>Recycling: Mechanical recycling in exceptional situations</li> <li>Technical properties of recycled plastics? Is there a market, are there product applications or not?</li> <li>No sub-optimization</li> <li>The price of recycled plastic vs. the price of virgin plastic</li> <li>Global market, how does the chain operate globally?</li> <li>Recycling favoured locally, production costs?</li> <li>Plastics education in universities, colleges, and educational institutions has decreased in the last decade</li> <li>There is a need for basic knowledge and training in plastics regarding different materials, their properties, technologies, etc. across the line. That is especially needed in the development of recycling and the take-up of bioplastics.</li> </ul>

### 3.1.5 Summary of SWOT analyses and the workshop in Finland

The table 6 provides a summary of strengths, weaknesses, opportunities and threats in the four thematic expertise areas identified by plastics packaging professionals in 10 years' timeframe.

TABLE 6. Summary of SWOT analysis regarding all thematic areas in Finland.

What are the most important knowledge, skills, and training needed in 10 years' timeframe?	
<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>• Currently, companies have strong substance expertise</li> <li>• A good time for change.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>• Lack of common terminology and communication (both consumers and professionals)</li> <li>• Joint development of LCA analyses (not generally comparable).</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>• Cooperation between different stake holders throughout the supply chain</li> <li>• Understanding the entire value chain</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>• Legislation does not support or even hinders innovation</li> <li>• Run-down of basic plastics education in Finland</li> </ul>

In general, the plastic packaging industry experts and stakeholders evaluated that subject-specific knowledge and skills are achieved well, though the radical decrease of plastics education is threatening that. However, the challenge is that the different industry sectors, companies, and public sector are still operating in silos. As for the shift towards the circular economy in the plastics packaging industry, all teams of the workshop acknowledged holistic knowledge and understanding of the supply and value chains as a critical dimension of competencies of the future professionals. E.g., there is a need for joint development of LCA analyses to provide comparable knowledge. There is also a need to acknowledge communications as an integral element in the transition to the circular economy. Currently, consumers are lost with the complex labelling systems of plastics, which makes recycling difficult. Within industry and experts, the terms are not clear either.

The outcomes were collected and are presented by using the framework of PackAlliance project consisting of four thematic areas. In team discussions, the borders of thematic areas were not distinct: development was seen as an interdependent process where, e.g., the activities in residue management have impact on material innovation. The systemic thinking of the circular economy should be noted in PackAlliance project as well. Although thematic distinctions are needed, their interdependency needs to be taken into account.

According to the feedback collected from the participants, inviting different stakeholders was both valuable and needed. All stakeholders of the value chain such as packaging industry,

retailers, EU/ legislation, raw material suppliers, educational institutes and consumers should be included in the development of packaging professions towards the circular economy.

### 3.2 Workshop Outcomes in Italy

The workshop in Italy followed the same procedure and general setting as the Finnish workshop (see table 1).

#### 3.2.1 SWOT analysis – New Materials and Bio-Based Materials

TABLE 7. SWOT analysis results regarding New materials and bio-based materials in Italy.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Skills on development of bioplastics and recycled materials are fundamentally integrated with design and production processes in order to create a more functional and eco-sustainable packaging</li> <li>- Optimization of properties and the compatibility of biopolymers with the current production system have to be considered and updated.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of specific courses concerning the fundamental properties and processing technologies of bioplastics, the differences within industrial and home composting, and the recycling technologies for multi-materials packaging.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>• Identification of applications for materials that are difficult to recycle</li> <li>• Production of mono-material products</li> <li>• Development of new techniques for the separation of multilayer packaging.</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Education and awareness of the final consumer</li> <li>- Nature of bioplastics, their shortage and high costs</li> <li>- Need to update or redesign process technologies.</li> </ul>

#### 3.2.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing

TABLE 8. SWOT analysis results regarding Eco-design and novel manufacturing processing in Italy

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Production process skills</li> <li>- Packaging redefining, from design to the mono-material used</li> <li>- UNI EN 13432:2002</li> <li>- Transversal skills in packaging sector.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of profiles with specific and different competences in terms of process, eco-packaging design, LCA</li> <li>- Assess indirect costs related to LCA study.</li> </ul>
<p><b>OPPORTUNITIES</b></p>	<p><b>THREATS</b></p>

<ul style="list-style-type: none"> <li>- LCA instruments</li> <li>- Background packaging experiences</li> <li>- Background bio-based experiences in terms of “waste”.</li> </ul>	<ul style="list-style-type: none"> <li>- Assess indirect costs related to LCA study</li> <li>- Poor perception of the actual impact of the different types of materials</li> <li>- Foreseen errors</li> <li>- Economic risks</li> <li>- Difficulty of spreading new CE eco-design information on company level.</li> </ul>
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### 3.2.3 SWOT analysis - Eco-Marketing and Citizen Interaction

TABLE 9. SWOT analysis results regarding Eco-marketing and citizen interaction in Italy

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Citizen education and training, especially young people</li> <li>- Transversal profiles with new materials skills.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- EU-wide common and clear guidelines for recycling</li> <li>- EU correctly labelling recycling</li> <li>- Lack of education on a global level (schools, communities, institutions) about recycling and sorting.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- Training courses on school and high institution level, involving organizations, government on national and regional level, communities, and citizens</li> <li>- Clear labelling can help recycling in the correct way.</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Incorrect information and education about “end-of-life”</li> <li>- Confusion between biomaterials and traditional materials.</li> </ul>

### 3.2.4 SWOT analysis - Residue management and valorisation

TABLE 10. SWOT analysis results regarding Residue management and valorization in Italy

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Eco-design skills</li> <li>- Storage in food packaging</li> <li>- Recycling guidelines.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lacking common EU guidelines about sorting</li> <li>- Skills for the re-design of products in term of new material properties</li> <li>- Information and dissemination about recycling equipment already used in Italy.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- Knowledge about different materials</li> <li>- Communication within production value chain.</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Lacking common EU guidelines about recycling</li> </ul>

	<ul style="list-style-type: none"> <li>- Contrasting and confused information does not help companies and final consumers</li> <li>- Lack of equipment for new recycled materials.</li> </ul>
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### 3.2.5 Summary of SWOT analyses and the workshop in Italy

The table 11 provides a summary of strengths, weaknesses, opportunities and threats in the four thematic expertise areas of plastics packaging professionals in 10 years timeframe.

TABLE 11. Summary of SWOT analysis regarding all thematic areas in Italy.

What are the most important knowledge, skills and training needed in 10 years timeframe?	
<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Previously acquired expertise/skills</li> <li>- Professional specialist profiles with transversal skills in the packaging sector (eco-design, biomaterials, new materials, technology process, etc.).</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Deficits on: packaging economic aspects, new material properties, new material eco-design, EU regulation aspects</li> <li>- Lack of specific training courses in this sector.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- In Italy, the overall climate for recycling plastic use, eco-design, LCA, innovation new materials and technology process is positive</li> <li>- External factors: training courses at school and high institution level, citizen interaction, eco-sustainable design, moving to mono material packaging</li> <li>- Regional government gives a large number of possibilities for public financing of hiring new profiles in the companies, in order to be directly trained while they are working.</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- The plastic training courses should be increased but in the past years, instead their number has been drastically reduced</li> <li>- Lack of common and clear guides and recycling labelling in Europe is a problem for instructing well-trained and competent professional figures.</li> </ul>

According to the participants' feedback and the discussions in the different workshop groups in Italy, several considerations and suggestions were expressed on the compilation of the SWOT analysis. In general, the participants agreed that it is essential to have a transversal approach in addition to subject-specific skills, especially on new materials. About training

courses, it is fundamental to involve all study levels (from schools and municipalities to institutions) and especially the consumers, to educate future students and workers towards the eco-sustainable way, and to mono-material packaging, in order to obtain important benefits gained for the whole sector.

A crucial challenge was the lack of common guidelines and labelling on European level, which plays a key role in promoting the development of recycling and awareness of new materials.

### 3.3 Workshop Outcomes in Poland

The workshop in Poland followed the same procedure and general setting as the Finnish workshop (see table 1).

#### 3.3.1 SWOT analysis – New Materials and Bio-Based Materials

TABLE 12. SWOT analysis results regarding New materials and bio-based materials in Poland.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Knowledge of material properties and their use</li> <li>- Ability to identify environmental aspects related to new materials</li> <li>- Knowledge of the influence of the materials used on the production process</li> <li>- Knowledge of consumer preferences and supplier market</li> <li>- Ability to use new business models based on the circular economy</li> <li>- Having innovative capacity in the field of supply.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of knowledge about the possibility of obtaining new materials with specific properties</li> <li>- Lack of knowledge about the possible use and the impact of new materials on the environment</li> <li>- Limitations resulting from the investments made in the field or "wrong choice" from the environmental point of view</li> <li>- Lack of knowledge and skills in using tools for environmental assessment, e.g. LCA</li> <li>- Technological limitations.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- High availability of new materials on the market</li> <li>- Modern technologies enabling the use of new materials</li> <li>- Supporting the possibility of using pro-ecological materials on the EU and national level through legal regulations and increasing public awareness</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Limited availability of new materials on the market</li> <li>- Too quick development of the market for new materials not adapting to the existing technology</li> <li>- Increasing competition on the market of new materials, which leads to their price increase.</li> </ul>



<ul style="list-style-type: none"> <li>- Greater availability to obtain preferential financing</li> <li>- Possibility of gaining knowledge and raising the qualifications in the field of pro-environmental competences (universities, training companies).</li> </ul>	
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### 3.3.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing

TABLE 13. SWOT analysis results regarding Eco-design and novel manufacturing processing in Poland.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Ability to identify the environmental aspects related to a product and to integrate them into the design process</li> <li>- Knowledge of the production process and product life cycle, which allows reducing the material and energy consumption of products along the entire value chain</li> <li>- Knowledge of consumer preferences and supplier market</li> <li>- Ability to use new business models based on the circular economy.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of awareness of the possibilities resulting from pro-ecological solutions</li> <li>- Lack of knowledge about the environmental impact of individual stages of the production process, e.g. the amount of pollution</li> <li>- Lack of knowledge about the possibility of using environmentally friendly materials</li> <li>- Limitations resulting from the investments made in the field or "wrong choice" from the environmental point of view</li> <li>- Limitations related to access to funds for investments and company development</li> <li>- Lack of knowledge and skills in using tools for environmental assessment, e.g. LCA.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- Support for pro-ecological innovations on the EU and national level through legal regulations and increasing social awareness</li> <li>- Greater availability to obtain preferential financing</li> <li>- Modern technologies enabling the use of the company's potential and gaining a competitive advantage</li> <li>- Opportunities to gain knowledge and improve skills in the field of</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Growing competition in the market of pro-environmental products and technologies</li> <li>- Too quick development of new technologies and their costs</li> <li>- New strategies and guidelines in terms of perception force companies to be environmentally friendly - increasing demands on environmental aspects</li> <li>- Necessity to have a license to enter the sector</li> </ul>



pro-environmental competences (universities, training companies).	- Increase financial burdens, e.g. introduction of new taxes.
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### 3.3.3 SWOT analysis - Eco-Marketing and Citizen Interaction

TABLE 14. SWOT analysis results regarding Eco-marketing and citizen interaction in Poland.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Knowledge of all stages of the product life cycle allowing the promotion of pro-environmental elements</li> <li>- Knowing the preferences and behaviour of consumers regarding product selection</li> <li>- Knowledge of the company's activities in the field of CSR in the environmental, economic and social aspects</li> <li>- Knowledge of new markets for products and services.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of knowledge about the idea of sustainable development and the circular economy</li> <li>- Low knowledge of the forms of communication conducive to increasing environmental awareness</li> <li>- Lack of knowledge about the environmental impact of individual stages of the production process, e.g. the amount of pollution, waste</li> <li>- Lack of knowledge about the possibilities of using materials and solutions in the field of RES</li> <li>- Lack of knowledge about the possibility of using EU funds</li> <li>- Lack of skills in creating the image of a pro-ecological company.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- Increased pro-ecological awareness of consumers thanks to the undertaken educational activities</li> <li>- A unified system of labelling products and the impact of the company's activity on the environment</li> <li>- Opportunities to gain knowledge and improve skills in the field of pro-environmental competences (universities, training companies).</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Lack of legal regulations on sustainable packaging</li> <li>- Growing competition in the field of pro-ecological activities</li> <li>- New strategies and guidelines for the perception of companies to be environmentally friendly and increasing environmental requirements.</li> </ul>

### 3.3.4 SWOT analysis - Residue management and valorisation

TABLE 15. SWOT analysis results regarding Residue management and valorization in Poland.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Knowledge about the use of modern technologies in the residual waste management sector in order to maintain / increase competitiveness and to reduce the environmental impact</li> <li>- Availability of the raw material base</li> <li>- Ability to process recyclable materials with the use of increasingly innovative processing and recycling technologies, which contributes to the improvement of the level of innovation in the Polish economy</li> <li>- Ability to establish cooperation along the entire value chain</li> <li>- Innovativeness in action</li> <li>- Ability to use new business models based on the circular economy.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of knowledge about advanced domestic technologies (technical and technological solutions) supporting the management of residual waste</li> <li>- Lack of knowledge in the field of substitution of raw materials and materials</li> <li>- Limitations related to access to funds for investments and company development</li> <li>- Limitations related to incurring high investment outlays in the area of technological facilities required for the processing and recovery of residual waste</li> <li>- Unused research and development potential and the lack of real cooperation between science and business in the waste management trade</li> <li>- Lack of R&amp;D facilities of private economic entities from the waste management sector, and very low possibilities of supporting research projects and, consequently, low involvement of production companies in R&amp;D related to the use of residual waste.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- Increasing environmental awareness, striving to increase the quality of life and work</li> <li>- Availability of technology and scientific achievements thanks to the increased participation of the R&amp;D sector in research projects</li> <li>- Access to machinery and equipment</li> <li>- Legal solutions supporting the residual waste management.</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Insufficient financial instruments supporting the residual waste management</li> <li>- Frequently changing legal regulations in the field of waste management</li> <li>- Low level of education on the possibility of using residual waste</li> <li>- Lack / imperfection of system solutions supporting the trade.</li> </ul>

### 3.3.5 Summary of SWOT analyses and the workshop in Poland

The following table 16 provides a summary of strengths, weaknesses, opportunities and threats in the four thematic expertise areas of plastics packaging professionals in 10 years timeframe.

TABLE 16. Summary of SWOT analysis regarding all thematic areas in Poland.

What are the most important knowledge, skills and training needed in 10 years timeframe?	
<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Use of modern technologies in the waste management sector thanks to developed knowledge and skills</li> <li>- Using new business models based on the circular economy</li> <li>- Innovativeness in economic activity</li> <li>- Technology and scientific achievements in the field of circular economy through cooperation between business and science.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of awareness of the need to use pro-ecological solutions</li> <li>- Unused research and development potential and the lack of real cooperation between science and business in the circular economy field</li> <li>- Poor environmental awareness</li> <li>- Lack of knowledge on how to handle waste</li> <li>- Limitations related to access to funds for investments and company development.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <ul style="list-style-type: none"> <li>- Increased pro-ecological awareness of consumers</li> <li>- Increase in the quality of life and work, thanks to the undertaken educational activities</li> <li>- A unified system of labelling products impact of the company's activity on the environment</li> <li>- Opportunities to gain knowledge and improve skills in the field of pro-environmental competences (universities, training companies).</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Frequently changing legal regulations in the field of waste management</li> <li>- Lack of a larger selection of specialized postgraduate studies in the field of circular economy</li> <li>- Insufficient financial instruments supporting pro-ecological investments</li> <li>- Lack / imperfection of system solutions supporting trades.</li> </ul>

According to the participants' feedback and during the discussions in the different workshop groups in Poland, several considerations and suggestions were expressed along with the compilation of the SWOT analysis. In general, it was agreed that it is essential to have transversal approach in addition to subject-specific skills especially on new materials.

The main conclusions are as follows:

1. The university graduates' and employees' knowledge and skills need to be supplemented. This particularly concerns LCA, the value and management of waste,

- design, production and analysis of the properties of functional materials of biological and medical importance, their application, and disposal methods.
2. Better cooperation between the science sector and business is necessary.
  3. The science sector should support business in two areas: searching for new solutions and providing knowledge about the LCA of existing packaging.
  4. The availability of the analysis of bio-based materials for various entities would be beneficial.
  5. An important aspect of eco-design for packaging in circular economy is the creation of integrated value and supply chains (raw material-product-raw material).
  6. It was also noted that the consumer awareness of bio-based materials is insufficient.
  7. Consumers also do not have sufficient knowledge about proper sorting of waste. There is not always complete information on products and packaging on how to handle them after use. The issue of residual waste sorting also turned out to be problematic.
  8. The changing legislation on plastic waste is also a big problem.

### 3.4 Workshop Outcomes in Spain

Organisers first defined the most relevant questions in order to guide the participants in the workshop. The selected questions related to each topic were:

Company questions:

- What knowledge does your company not have but needs?
- What profiles do you find in the market?
- What will be the most demanded skills in 5 years?
- What would be essential for your new worker to know?

Environment questions:

- What opportunities do you exploit in terms of circular economy?
- What factors hold back the commitment to a business more focused on sustainability?
- What are the benefits of working in the circular economy sector?
- What can make the circular economy a non-profitable business?

Participants were divided into 4 groups (according to their knowledge):

- New materials and bio-based materials
- Eco-Design and Novel Manufacturing Processing
- Eco-Marketing and Citizen Interaction
- Residue management and valorisation

Each team's task was to build a SWOT analysis of the most relevant knowledge and skills of packaging professionals in 10 years timeframe in the respective thematic field.

The general setting of the analysis task was same as in the other countries (see table 1). After the teamwork, the outcomes were discussed with all participants of the workshop. At that

stage, the results were supplemented by comments raised in this general discussion. The workshop was conducted in Spanish, and the outcomes were translated into English.

### 3.4.1 SWOT analysis – New Materials and Bio-Based Materials

TABLE 17. SWOT analysis results regarding New materials and bio-based materials in Spain.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Professionals have the opportunity to acquire technical knowledge of materials and their properties according to specific applications</li> <li>- Companies are looking for a global vision of the product life cycle through eco-design and knowledge about sustainability and circular economy of materials and packaging</li> <li>- Professionals working in the packaging sector have to keep up-to-date with new materials and technologies, as well as learn about market trends</li> <li>- Acquired skills in circular economy and packaging help to understand the process and the limitations of materials and products</li> <li>- Companies promote interdisciplinary teamwork and collaboration.</li> </ul>	<p><b>WEAKNESSES</b></p> <p><b>Existing staff of companies in this sector do not have the necessary knowledge about:</b></p> <ul style="list-style-type: none"> <li>- Types of new materials and their recyclability, characteristics, applications and origin</li> <li>- How are the new polymers transformed: Materials processing</li> <li>- Ecological footprint of the new materials.</li> </ul> <p><b>Need of the following profiles in the labor market:</b></p> <ul style="list-style-type: none"> <li>- Experts in bio-based and compostable materials, packaging materials and their properties</li> <li>- Comprehensive view of packaging in the context of the product</li> <li>- National bio-based manufacturers.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <p><b>Current opportunities to exploit in the circular economy sector are:</b></p> <ul style="list-style-type: none"> <li>- Use of recyclable materials or materials with recycled percentage</li> <li>- Use of bio and compostable sources</li> <li>- Minimizing of unnecessary plastic.</li> </ul> <p><b>Benefits of working in the circular economy sector are:</b></p> <ul style="list-style-type: none"> <li>- Adaptation to current and future regulations</li> <li>- Professional ethics and commitment to the environment</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Use of new materials and bio-based materials increases product costs and reduces the useful life of the product</li> <li>- Lack of information and means to manage these materials in the residual phase and lack of structures for the return system</li> <li>- Properties of the biomaterials do not meet the product requirements</li> <li>- Landfill is more profitable than recycling</li> <li>- There are not enough resources and local, national or European aids for implementing a circular economy model in companies.</li> </ul>

<ul style="list-style-type: none"> <li>- It is a current and future market trend and companies struggle to stay in the market.</li> </ul>	
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### 3.4.2 SWOT analysis - Eco-Design and Novel Manufacturing Processing

TABLE 18. SWOT analysis results regarding Eco-design and novel manufacturing processing in Spain.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Knowing the strengths of the circularity of the materials and packaging allows educating the consumer and boosting sales</li> <li>- Skills in circular economy, packaging, and LCA help to understand the manufacturing processes, benefits, and limitations of materials and products</li> <li>- Boosting teamwork will lead to successful, as well as sustainable, products</li> <li>- Knowing the legislation allows companies to benefit from their strengths and detect weaknesses, which they can improve.</li> </ul>	<p><b>WEAKNESSES</b></p> <p><b>Existing staff of companies in this sector do not have the necessary knowledge about:</b></p> <ul style="list-style-type: none"> <li>- LCA knowledge</li> <li>- How to really identify the degree of sustainability of certain materials to avoid greenwashing</li> <li>- Real impact of new materials</li> <li>- Real information on whether the materials are recycled or not</li> <li>- ECO packaging market trends - the possibilities that are emerging</li> <li>- Legislation regarding the use of non-biodegradable plastics - plastics environmental legislation</li> <li>- Knowledge of user / consumer behavior and experience.</li> </ul> <p><b>Need of the following profiles in the labor market:</b></p> <ul style="list-style-type: none"> <li>- Product designers specialized in packaging</li> <li>- Experts in plastic recycling and end-of-life technologies</li> <li>- Experts in circular economy</li> <li>- Experts with a complete vision of the product life cycle</li> <li>- Experts in end of life management of plastics derived from petroleum.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <p><b>Current opportunities to exploit in the circular economy sector are:</b></p> <ul style="list-style-type: none"> <li>- Development of alternative raw materials (recycled content, CO<sub>2</sub> uptake, of bio origin)</li> <li>- Increase the circularity of plastics with new recycling technologies</li> </ul>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Investment costs of implementing sustainable production processes</li> <li>- Non-competitive prices compared to traditional plastics</li> <li>- There are no quality standards regarding bioplastics</li> </ul>

<p>such as chemical recycling - use of waste to give them a second life</p> <ul style="list-style-type: none"> <li>- Ecodiagnostics capacity</li> <li>- Raise awareness and educate on the proper management of waste.</li> </ul> <p><b>Benefits of working in the circular economy sector are:</b></p> <ul style="list-style-type: none"> <li>- Better use of resources and processes</li> <li>- Creation of new profitable business.</li> </ul>	<ul style="list-style-type: none"> <li>- Corporate reluctance to move from a linear economy to a circular economy</li> <li>- Settled deadlines may not help the transition - risk that public strategies and policies do not accompany companies</li> <li>- Consumers' final decision is prioritized on the price rather than on sustainability</li> <li>- Unfair competition.</li> </ul>
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### 3.4.3 SWOT analysis - Eco-Marketing and Citizen Interaction

TABLE 19. SWOT analysis results regarding Eco-marketing and citizen interaction

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Make a more efficient use of natural resources</li> <li>- Design allowing separation of materials at the end of life of a packaging material</li> <li>- Awareness campaigns based on sustainability of the packaging are working better now due the increased sensibility of consumers.</li> </ul>	<p><b>WEAKNESSES</b></p> <p><b>Existing staff of companies in this sector do not have the necessary knowledge about:</b></p> <ul style="list-style-type: none"> <li>- Active listening and how to incorporate this information to the company strategy.</li> <li>- Consumer behaviors, motivation, ability to manage waste.</li> <li>- Business models that engage consumers through sustainability.</li> <li>- Tools for accessing and staying in touch with consumers.</li> </ul> <p><b>Need of the following profiles in the labor market:</b></p> <ul style="list-style-type: none"> <li>- Professionals able to think out of the box</li> <li>- LCA experts</li> <li>- Professionals with innovation methodologies and eco-marketing knowledge</li> <li>- Experienced professionals in sustainable branding.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <p><b>Current opportunities to exploit in the circular economy sector are:</b></p> <ul style="list-style-type: none"> <li>- Eco-marketing strategies and positioning</li> </ul>	<p><b>THREATS</b></p> <p><b>Stoppers that reduce the impact on a business concept more oriented to sustainability are:</b></p> <ul style="list-style-type: none"> <li>- Big variety of materials can be confusing for consumers</li> </ul>



<ul style="list-style-type: none"> <li>- Telling histories as a way to increase the effectiveness of anything surrounding circular packaging</li> <li>- Campaigns based on awareness highlighting the importance of responsible consuming and the correct separation of waste</li> <li>- Raise citizens' consciousness about the fact that Circular Economy profits are not only profitable for companies, but they are also key elements in the future development of society.</li> </ul> <p><b>Benefits of working in the circular economy sector are:</b></p> <ul style="list-style-type: none"> <li>- It is possible to improve company's positioning for adopting a more proactive strategy about sustainability</li> <li>- It is possible to earn market share through a bigger percentage of aware citizens.</li> </ul>	<ul style="list-style-type: none"> <li>- It is difficult to explain that economic cost is not the only cost associated with a product</li> <li>- Some groups are not aware enough for paying the extra cost of circular products</li> <li>- Some companies are using greenwashing strategies, which makes it difficult for the reliability of the sector.</li> </ul> <p><b>Key factors that can make Circular Economy a non-profit business are:</b></p> <ul style="list-style-type: none"> <li>- A not strong enough regulatory framework against disposable products</li> <li>- Failing at concerning citizens about profitability as a much more relevant factor than the strictly economic view</li> <li>- Consumers not assuming that protection of the environment entails an extra cost.</li> </ul>
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### 3.4.4 SWOT analysis - Residue management and valorisation

TABLE 4. SWOT analysis results regarding Residue management and valorization in Spain.

<p><b>STRENGTHS</b></p> <ul style="list-style-type: none"> <li>- Circular Economy is being increasingly encouraged</li> <li>- Circular Economy can achieve common welfare, sustainability and job creation.</li> </ul>	<p><b>WEAKNESSES</b></p> <ul style="list-style-type: none"> <li>- Lack of awareness about how recycling processes work</li> <li>- It is necessary to know if something is not working in the recycling process</li> <li>- More innovation is required in order to use 100% recyclable materials</li> <li>- SMEs do not always have the support to adapt to the regulations.</li> </ul>
<p><b>OPPORTUNITIES</b></p> <p><b>Circular economy would allow:</b></p> <ul style="list-style-type: none"> <li>- Generation of a second-life for packaging materials</li> <li>- Implementation of sustainability throughout the entire life cycle of a packaging material.</li> </ul> <p><b>Key factors that could carry benefits in our sector are:</b></p>	<p><b>THREATS</b></p> <ul style="list-style-type: none"> <li>- Ignorance of materials and how to generate value with waste</li> <li>- Uncertain legislative framework (lack of homogeneity)</li> <li>- The lack of a fair transition that aids SMEs to adapt to the new framework.</li> </ul>



<ul style="list-style-type: none"><li>- Graduates will have in-depth knowledge in all kinds of plastics.</li><li>- Erasmus+ students will learn other languages.</li></ul>	
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### 3.4.5 Summary of SWOT analyses and the workshop in Spain

According to the participants' feedback and during the discussions in the different workshop groups in Spain, several considerations and suggestions emerged during the compilation of the SWOT analysis. In general, it is agreed that there is a lack of knowledge on plastics packaging, even among professionals. More information on the recycling process, as well as the promotion of tools that allow traceability of the disposed materials, is required. Furthermore, companies are especially concerned about new regulations. They ask for support to comply with them. In all, it is agreed that more training in CE related topics is needed to reach higher recycling ratios.

### 3.5 Summary of the workshop results in the four countries

The workshops were conducted in very different contexts; therefore, the SWOT analyses are not fully comparable. Here we have pointed out three common themes discussed in the workshops in all countries. As for competency needs, LCA (life-cycle assessment) knowledge and skills were emphasized in all countries and all thematic areas. Legislation and regulations regarding plastics packaging were seen as both a threat and also as an opportunity that may hinder or enhance innovations towards CE. The ability to understand and collaborate with different kinds of stakeholders was highlighted in all workshop results.

In SWOT analyses, understanding of LCA was crucial in all four thematic areas, and the term was noticed in all dimensions (strength, weakness, opportunity, threat). While discussing strengths, LCA helps in understanding manufacturing processes, benefits, and limitations of materials and products. However, there is a lack of knowledge and skills on how to use LCA as a tool in all countries (weakness). Since LCA can be based on different objectives and be done in multiple ways, there is a risk of making wrong decisions e.g., underestimating the indirect costs of manufacturing (threat). LCA can be an opportunity for understanding the whole supply chain, not only from the point of plastics packaging. LCA provides a means to understand the terminology related to the new materials and biobased materials.

According to SWOT analyses, legislation and regulation related to plastics packaging are considered an opportunity in the field of new materials and bio-based materials. On the other hand, it is questioned what kinds of regulations there are, or should be, regarding sustainable development, and what do specific concepts, such as recyclability, mean in legislation? These questions relate to plastic materials and eco-design, as well as manufacturing processing and residue management. In eco-marketing and citizen interaction, EU legislation and regulations are considered an opportunity from the viewpoint of brands. However, they are also seen as

a threat, because regulations on sustainable packaging are lacking. In all countries, the legislation does not seem to support innovations a sufficient manner. Frequent change of regulations in the field of waste management is a threat that affects to all four thematic areas.

SWOT analyses reveal strengths in working methods inside companies, such as collaboration and multidisciplinary teamwork, networking (especially international networks), benchmarking, and knowledge sharing. These identified good practices can be used to tackle weaknesses and threats (opportunity). On the other hand, SWOT analyses provided a result that e.g. collaboration is still occurring in silos, even though cross-sector collaboration between different parts and sectors of supply and value chain is needed. Among others, that includes global visioning and the ability to understand customers and the market to innovate business models related to CE. These identified working methods and attitudes can be a key to teach CE plastics packaging professionals.

## 4. Discussion

The study, including the survey and interviews, and the SWOT analysis workshop in all countries, complemented each other well. In both activities, collaboration and information sharing of different plastics packaging industry stakeholders were emphasised as a crucial requirement in the transition to the circular economy. In defining that, the workshops turned out very valuable. According to the participants' feedback, inviting and including representatives from different parts of the supply chain triggered discussion in the right direction.

While the survey and interviews provided systematic information about the skills shortages and educational needs, the workshops provided complementary insights into the thematic focus areas.

**In New materials and bio-based materials**, the holistic understanding of supply and value chains and LCA development was emphasised in both the study and the workshop as a critical quality of future plastics packaging professionals. As for subject-specific competencies, the knowledge of characteristics of materials, such as compostability and biodegradability of new, possibly biobased materials, is essential. The terms (e.g. the terms mentioned earlier) need consideration and development to be comprehensible in the industry. Therefore, professionals should understand the communications dimension of new material development. They also need to know the legislation for following that, and for understanding the opportunities and limits of regulations. Consequently, new material developers should act as catalysts in discussions regarding the preparation of new legislation for ensuring that the viewpoint of new materials is taken into account. A big problem in this field is the lack of specific courses concerning, e.g., the fundamental properties and processing technologies of bioplastics, the differences within industrial and home composting and the recycling technologies for multi-materials packaging.

**In Eco-design and novel manufacturing processing**, future professionals should adjust and develop the existing manufacturing technologies to be suitable for new materials. Managing investments was discussed as a relevant competency area, because investment decisions have long-term effects (either positive or negative) on the circular economy development. Common understanding of terminology, even the basic term 'ecological', was seen lacking. That leads, again, to highlight the communications competency as part of a profession. Although some workshop results indicated that traditional eco-design (including, e.g., optimisation of weight and size) is already a strength of plastic packaging professionals, the survey showed that this field is still an important theme for training. Eco-design related to recycling trends was seen important in the study, and mentioned as an opportunity in the workshop results. Reducing emissions and electricity consumption have also been intentionally addressed in the industry.

**In Eco-marketing and citizen interaction**, the biggest challenge is the confusing terminology of packaging labels, which makes it difficult for consumers to recycle plastic packages. Plastics packaging professionals should understand the consumers better. The workshop participants were worried about the conflicting or inaccurate information regarding plastics in media. On the other hand, communication in the industry was critically reflected upon. Some companies still practice greenwashing rather than work for the circular economy. Therefore, the industry needs to enhance communication to be simple for consumers and citizens, and factual at the same time. Business models that engage consumers through sustainability are also needed. The circular economy approach, with an understanding of plastics, should be included in the whole education system. Since recycling is a crucial requirement for sustainable plastics packaging, the industry should know better how to encourage consumers and citizens to do it. Thus, for developing the plastics packaging industry profession, consumer understanding and communication skills are crucial. The need to extend education in the field of CE and plastic packaging (including recycling and sorting) to all school levels, from primary and secondary school to vocational training and higher education, was highlighted in the study and workshops. Communities, public organisations, and institutions should also be involved in achieving better results.

**In Residue management and valorization**, the need for interaction with the other parts of the supply chain arose. Recycling technologies and methods should be developed hand in hand with material and product development in multidisciplinary settings. There is also a need for information sharing between companies and stakeholders in the industry to implement the best solutions and make the recycling more standard. In threats, recycled plastics were still seen as a product with a labile market that can be too costly. Thus, the reusability of packages is an important topic raised by some industry representatives in the survey and the workshops. As mentioned earlier, the reusability of packages was not among the listed expertise fields in the survey, and it is a valuable addition to those. In brief, residue management and valorization also require a holistic understanding of the value and supply chains. While discussing subject-specific expertise, the utilization of IoT and sensing systems, for example, were seen as future opportunities. In general, the professionals need to cope with the accelerating pace of change

in the industry and the surrounding world and be capable of continuously updating their knowledge.

The participants of the study and the workshops were motivated to contribute to the development of plastics packaging curricula in higher education. In the study, the need for multidisciplinary collaboration between different parts of the supply and value chains was expressed by individual industry representatives.

In the PackAlliance project, plastics packaging has been divided into four thematic competency fields and training modules: New materials and biomaterials, Eco-design & novel manufacturing processing, Citizen interaction & eco-marketing, and Residue management and valorization. In the study and workshops, this division proved out to be very useful for digging deeper into the educational needs in those specific fields. However, a requirement expressed by the plastics packaging industry in all countries was a cross-sectoral understanding of the supply and value chain. When generating new competence-based educational offer, the plastics packaging industry demands it important not to think of the four thematic areas only as independent training modules, but as a whole package to meet the right kind of needs in the field of CE. In the circular economy, no professional, company, or other organization can act in their silos.

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**The information and views set out in this report are those of the authors and do not necessarily reflect the official opinion of the European Union. Neither the European Union institutions and bodies nor any person action on their behalf may be held responsible for the use which may be made of the information contained therein.**



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