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ANALYSIS OF TRAINING OFFERS ABOUT CIRCULAR ECONOMY IN SPANISH HIGHER EDUCATION

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Circular Economy (CE) implementation in the study plans ensures that students have the necessary training about it. Higher education students would be in near future responsible for implementing the circularity from the earliest phases of their projects. This will allow the concept of Circular Economy arrive at mainstream. This work analyses the higher education master and postgraduate courses offers in Spain in the professional fields closer to the CE. A total of 44 offers have been analyzed. These studies are in the fields of industrial design, waste management and sustainability, business and architecture. For each, it has been analyzed which of the areas included in the CE are taught. The results show that the implementation of many contents related to CE in still low, mainly in circular design, social design, resource cascade and performance economy.

Keywords: *Circular Economy; Training offers; Higher education*

ANÁLISIS DE LA OFERTA EDUCATIVA SOBRE ECONOMÍA CIRCULAR EN LA EDUCACIÓN SUPERIOR ESPAÑOLA.

La implantación de la Economía Circular (CE) en los planes de estudio asegura que los estudiantes tengan la formación necesaria al respecto, ya que son los que en un futuro se encargarán de implementar la circularidad desde las fases más tempranas de sus proyectos, permitiendo que el concepto de Economía Circular se extienda de una forma cada vez más general. Así, se ha estudiado la oferta educativa universitaria en España, seleccionando estudios de entre los campos relacionados con la Economía Circular. Se han analizado 44 ofertas en total compuestas por masters oficiales, cursos de postgrado y grados de los ámbitos del diseño industrial, gestión de residuos y sostenibilidad, modelos de negocio y arquitectura. De cada una de las ofertas, además de una clasificación del tipo y duración de estudios, se ha analizado qué ámbitos de entre los incluidos en la CE se imparten. Los resultados muestran que el 54,5% de las ofertas analizadas hablan en mayor o menor grado sobre Economía Circular, bien desde la perspectiva ambiental, la económica o la de diseño. Ninguna de las ofertas imparte exclusivamente contenido sobre CE.

Palabras clave: *Economía Circular; Oferta educativa; Educación superior*

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1. Introduction

Circular Economy (CE) is considered as a sustainable alternative to the Linear Economy based on the “take-make-use-dispose” model. However, the degree of implementation is still low. The European Commission has adopted a Circular Economy Package, which includes measures that will help stimulate Europe's transition towards a circular economy, boost global competitiveness, foster sustainable economic growth and generate new jobs. The proposed actions will contribute to "closing the loop" of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy. One of the proposals is to implement economic incentives for producers to put greener products on the market and support recovery and recycling schemes (COM/2015/0614 final). Changing to CE could lead to 1 tril-lion US$ that will be generated by the global Circular Economy (McKinsey and Company, 2012).

Designers are one of the crucial agents to achieve a greater implementation of the Circular Economy. For this reason, it is necessary to train design students on this aspect (RSA,2016). Providing that designers have knowledge about the Circular Economy they can advise and lead companies to change practice (Andrews, 2015). So, education programmes in higher education institutions should prepare the future professionals for the CE context. The Higher Education Academy (HEA) from UK recommends that UK Universities offer high quality professional development programmes on sustainability and the green economy for local and regional employers (Luna et al, 2012). Moreover, recent studies reveal that a wide range of design skills is needed to support circular economy; ranging from deeper knowledge of material science, engineering techniques and operational processes, through to proficiencies in design service and a deep knowledge of human behavior (De los Rios & Charnley, 2017).

This work has been developed in the context of the KATCH_e Project, a 3-year EU-funded project involving 11 institutions from 4 countries and which main objective is to build competences in the field of product-service development for the circular economy (CE) and sustainability in the construction and furniture sectors. In order to develop the aim of the project, one of the first stages is to analyse the training offers that have already been implemented, in order to understand the current training needs (Ruiz-Pastor et al, 2017).

Learning about the educational offer related to the Circular Economy at a national level is one of the objectives of the project, which is why the training offered about CE in Spain has been analysed. To develop the analysis, it has been established a list of topics about Circular Economy, grouped in three categories: Environmental, Economics and Design:

- Environment: Circular Economy topic, Resource Efficiency, Resource Cascading and Reuse / Repair / Remanufacture / Recycle in Environmental group.
- Economics: Industrial Symbiosis, Sustainable Business Model, Product-Service Systems, Circular Business Model and Performance Economy in Economic group.
- Design: Design for Sustainability, Circular Design, Cradle to Cradle Design (C2CD), Social Innovation and Design for Social Innovation in Design group.

2. Objectives

The aim of this paper is to know the current training offer about Circular Economy in industrial design, waste, business, sustainability and architecture fields in Spanish universities. Furthermore, it is aimed to see the weaknesses in the curricula in the topics covered under the circular economy umbrella.

The ultimate goal is to facilitate and focus the introduction of the CE into higher education, in the topics identified above, in accordance with the objectives of the KATCH_e project.

3. Method

Spanish masters, postgraduate courses and independent courses are analysed. Bachelor Degrees are not considered in the study. The steps followed to identify the Spanish University training offers about Circular Economy in are:

1. To identify the Spanish offers with contents about CE. Providing that designers, architects, engineers and business people are the main professional profiles that will make decisions that will help to implement CE in practice, the courses selected are those about design, sustainability, waste, architecture and business. All the design offers are analysed. For the other fields, only the 25% of the universities are studied. The criteria to select the 25% is: all the technical universities plus those with more students, that is, the bigger ones.
2. To analyse the contents of the offers. Regarding the Design offers, all of the universities and high education institutions have been considered. In the other thematic groups: waste, business, sustainability and architecture, only those offers which include any of the Circular Economy topics are selected for the study and analyzed.
3. To review the study plans to find how many items in their modules coincide with the CE topics and subtopics.
4. To quantify the results.

4. Results

The analysis includes a total of 44 offers between official masters, postgraduate courses and independent courses. The offers analysed are distributed in 24 masters of design, 3 masters of waste, 8 masters of sustainability and environment, 4 of architecture and construction and 2 of business and management. Also there are 3 reference offers, those which deal with Circular Economy as a concept, not just with some related topics. Out of the total of the offers analysed, only 7 (16 %) are distance learning or offer the possibility not to attend to all the lessons. Next tables summarise the analysis. When “Others” is written, it means that the course/master talks about Circular Economy at some point, but out of the topics.

For the REFERENCE offers, the most frequent topics group is the environmental one, in particular, the 3 offers include the Circular Economy topic. There is not content about Design and, in the Economic group, there is only content about Circular Business Models. Thus, in the Reference offers group, there is not content about Resource Efficiency, Resource Cascading, Reuse/Repair/Remanufacture/Recycle, Industrial Symbiosis, Product-Service Systems, Performance Economy, Design for Sustainability, Circular Design, Cradle to Cradle Design (C2CD), Social Innovation and Design for social Innovation. The “Master in applied Circular Economy” talks about strategies and tools for companies, as well as opportunities that CE introduction can provide them. On the other hand, the “Circular Economy in Industry” course has content about CE management in companies (Table 1).

Two of the three offers in the waste fields have explicit modules about Circular Economy concept and about Reuse/Repair/Remanufacture/Recycle. It has been found only two business master offers in Spain that includes specific content about Circular Economy in the programme description. In one offer, there are contents about Design for Sustainability and “Others”, so there is not information about any of the other topics and Environmental and Economic groups are not covered (Table 2). The only specific item included in business offers is design for sustainability (Table 3).

Table 1. Reference offers

		Master en Economía Circular Aplicada	*Experto en Economía Circular: principios de la sostenibilidad*	*Circular Economy in industry*	3
	INSTITUTION	Universidad San Jorge and Cámara de Comercio de Barcelona	CERpIE - Universitat Politècnica de Catalunya	Coordinador estatal de ciencias ambientales	
TYPE	Master	x			1
	Postgraduate course				0
	Course		x	x	2
MODE	On-Site	x	x		2
	E-Learning			x	1
	DURATION	1000 hours	4 créditos	60 hours	
KATCH_e TOPICS					
ENVIRONMENTAL	Circular Economy	x	x	x	3
	Resource Efficiency				0
	Resource Cascading				0
	Reuse/Repair/ Remanufacture/Recycle				0
ECONOMIC	Industrial Symbiosis				0
	Sustainable Business Model				0
	Product-Service Systems				0
	Circular Bussiness Models	x			1
	Performance Economy				0
DESIGN	Design for Sustainability				0
	Circular Design				0
	Cradle to Cradle Design (C2CD)				0
	Social Innovation				0
	Design for Social Innovation				0
	Others		X		1
		2	2	1	

Table 2. Waste courses

		Master in Gestión Sostenible de los Residuos	Master Propio en Gestión, tratamiento y aprovechamiento de residuos	Economía circular y gestión de residuos	3
	INSTITUTION	Universidad Politécnica de Madrid and Ecoembes	Universidad de Valencia	Universidad Politécnica de Madrid	
TYPE	Master	x		x	2
	Postgraduate course		x		1
	Course				0
MODE	On-Site	x		x	2
	E-Learning		x		1
	DURATION	750 hours	62 créditos	90 créditos	
KATCH_e TOPICS					
ENVIRONMENTAL	Circular Economy	x		x	2
	Resource Efficiency				0
	Resource Cascading				0
	Reuse/Repair/ Remanufacture/Recycle	x		x	2
ECONOMIC	Industrial Symbiosis				0
	Sustainable Business Model				0
	Product-Service Systems				0
	Circular Bussiness Models				0
	Performance Economy				0
DESIGN	Design for Sustainability				0
	Circular Design				0
	Cradle to Cradle Design (C2CD)				0

	Social Innovation				0
	Design for Social Innovation				0
	Others	X	X		2
		3	1	2	

Table 3. Business courses

		Máster en Comunicación social	*Gestión de la Innovación aplicada a producto*	2
	INSTITUTION	Complutense de Madrid	Universidad Europea del Atlántico	
TYPE	Master	x		1
	Postgraduate course			0
	Course		x	1
MODE	On-Site	x		1
	E-Learning		x	1
	DURATION	120 créditos	380 hours	
	KATCH_e Topics			
ENVIRONMENTAL	Circular Economy			0
	Resource Efficiency			0
	Resource Cascading			0
	Reuse/Repair/ Remanufacture/Recycle			0
ECONOMIC	Industrial Symbiosis			0
	Sustainable Business Model			0
	Product-Service Systems			0
	Circular Bussiness Models			0
	Performance Economy			0
DESIGN	Design for Sustainability		x	1
	Circular Design			0
	Cradle to Cradle Design (C2CD)			0
	Social Innovation			0
	Design for Social Innovation			0
	Others	X	x	1
		1	2	

For the DESIGN offers, all the topic groups (environmental, economic and design) are covered, and the most frequent is “Design”. Concerning the particular topics, the most common topic is Design for Sustainability, which is in 10 of 24 offers. “Product-Service Systems” topic is in 5 offers and Reuse/Repair/Remanufacture/Recycle is in 4. The Sustainable Product Design Master (IED Barcelona) and the Design Engineering Master (Universidad Politécnica de Valencia) cover 4 topics including two topic groups each. Any of the 24 design offers includes Resource Cascading, Sustainable Business Model, Circular Business Models, Performance Economy, Circular Design and Design for Social Innovation (Table 4).

For the SUSTAINABILITY offers, contents about the Design group are the most common (in 4 of the 8 offers with 3 of its topics covered, followed by the Economic group. Design for Sustainability is the most common topic (4), followed by the Sustainable Business Model (in 2). The Master’s Degree in Sustainability Science and Technology from the Universidad Politécnica de Barcelona is the offer in this group with more topics covered: Industrial Symbiosis, Product-Service System, Cradle to Cradle Design and Others. The three topic groups are covered by separate in the offers, but there is not information about Resource Cascading, Circular Business Models, Performance Economy, Circular Design and Design for Social Innovation in any (Table 5). For the ARCHITECTURE offers, three of the masters present specific contents about Design for Sustainability and the other one about Circular Design. One of them talks also about Reuse/Repair/Remanufacture/Recycle and another one about industrial symbiosis. There is not subjects about many of the topics targeted under the Circular Economy umbrella (Table 6).

Table 4. Design courses

		Sustainable Product Design: innovation and management	*Design for Sustainability*	*Industrial Design Master*	*Industrial Design Engineering Master*	*Installation and Product Design Master*	*Computer Aided Design and Manufacturing Master*	*Design Engineering Master*	*Design and Manufacturing Master*	*Product Design Engineering Master*	*Strategic Design of Products and Services*
	INSTITUTION	IED Barcelona	Universitat Oberta de Catalunya (UOC)	Universidad de Nebrija	Universidad Politécnica de Madrid	Universidad de Sevilla	Universidad Politécnica de Valencia	Universidad Politécnica de Valencia	Universitat Jaume I	Universidad de Zaragoza	Universidad de Mondragón
TYPE	Master	X		X	X	X	X	X	X	X	X
	Postgraduate Course		X								
	Course										
MODE	On-Site	X		X	X	X	X	X	X	X	X
	E-Learning		X								
	DURATION	750 hours	325 hours	750 hours	750 hours	750 hours	750 hours	750 hours	937,5 h	750h	1500h
ENVIRONMENTAL	Circular Economy	X									
	Resource Efficiency		X								
	Resource Cascading										
	Reuse/Repair/Remanufacture/Recycle	X			X		X		X		
ECONOMIC	Industrial Symbiosis					X					
	Sustainable Business Model										
	Product-Service Systems							X		X	X
	Circular Business Models										
	Performance Economy										
DESIGN	Design for Sustainability	X	X		X	X	X	X	X	X	
	Circular Design										
	Cradle to Cradle Design (C2CD)	X									
	Social Innovation							X			
	Design for Social Innovation										
	Others			X	X	X	X	X	X	X	
		4	2	1	3	3	3	4	3	3	1

		Product Concept Postgraduate	*Product Development Postgraduate*	*Furniture Design Master*	*Furniture Design for Collectivities, Contract and Urban Postgraduate*	*Furniture Design for Habitat Postgraduate*	*Industrial Design Engineering Master*	*Expert course in Product Design for Kitchen and Table*	*Product Design and Development Master*	*Smart Products Design Master*	*Digital Design and Manufacturing Master*
	INSTITUTION	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	ELISAVA	Universidad Autónoma de Barcelona	Universidad Europea de Madrid
TYPE	Master			x			x		x		x
	Postgraduate Course	X	X		x	x		x		x	
	Course										
MODE	On-Site	X	X	x	x	x	x	x	x	x	x
	E-Learning										
	DURATION	375 hours	375 hours	750 hours	375 hours	375 hours	750 hours	187,5 hours	750 hours	375 hours	750 hours
					KATCH_e TOPICS						
ENVIRONMENTAL	Circular Economy						X				
	Resource Efficiency										
	Resource Cascading										
	Reuse/Repair/Remanufacture/Recycle										
ECONOMIC	Industrial Symbiosis										
	Sustainable Business Model										
	Product-Service Systems								X		x
	Circular Business Models										
	Performance Economy										
DESIGN	Design for Sustainability			X	X						
	Circular Design										
	Cradle to Cradle Design (C2CD)										
	Social Innovation										
	Design for Social Innovation										
	Others	X	X	X	X	X	X	X	X	X	x
		1	1	2	2	1	2	1	2	1	2

		Product Design Master	*Master de estudios avanzados en diseño*	*Architecture, Design and Innovation Master*	*Design Engineering Master*	24
	INSTITUTION	Universidad CEU Cardenal Herrera	Universidad de Barcelona	Universidad Europea de Valencia	UNED	
TYPE	Master	X	x	x	x	18
	Postgraduate Course					6
	Course					1
MODE	On-Site	X		x		21
	E-Learning			x	x	3
	DURATION	750 hours	60 créditos	750 hours	187,5 hours	
			KATCH_e TOPICS			
ENVIRONMENTAL	Circular Economy					2
	Resource Efficiency					1
	Resource Cascading					0
	Reuse/Repair/Remanufacture/ Recycle					4
ECONOMIC	Industrial Symbiosis					1
	Sustainable Business Model					0
	Product-Service Systems					5
	Circular Business Models					0
	Performance Economy					0
DESIGN	Design for Sustainability					10
	Circular Design					0
	Cradle to Cradle Design (C2CD)					1
	Social Innovation					1
	Design for Social Innovation					0
	Others	X		x	x	21
		1	0	1	1	

Table 5: Sustainability courses

		International Master in Sustainable Development and Corporate Responsibility	*Postgraduate in Green Economy*	*Master Universitario en Intervención Sostenible en el Medio Construido*	*Master's degree in Sustainability Science and Technology*	*Master's Degree in Environmental Engineering*	*Máster en Eficiencia Energética, Cambio Climático y Sostenibilidad*	*Máster en Análisis y Gestión Ambiental*	Máster en Ingeniería Ambiental	8
	INSTITUTION	Escuela de Organización Industrial (EOI), Madrid	Universitat de Vic y Colegio de Economistas de Cataluña	Universidad Politécnica de Cataluña	Universidad Politécnica de Cataluña	Universidad Politécnica de Cataluña	Universidad de Alcalá	Universidad de Málaga	Univ. Santiago Compostela	
TYPE	Master	x		x	x	x	x	x	x	7
	Postgraduate Course		x							1
	Course									0
MODE	On-Site	x	x	x	x			x	x	6
	E-Learning						x			2
	DURATION	600 hours + final project	No info	60 ECTS	120 ECTS	No info	60 créditos	60 créditos	60 créditos	
ENVIRONMENTAL	Circular Economy		x							1
	Resource Efficiency							x		1
	Resource Cascading									0
	Reuse/Repair/Remanufacture/Recycle				x					1
ECONOMIC	Industrial Symbiosis				x					1
	Sustainable Business Model	x	x							2
	Product-Service Systems				x					1
	Circular Business Models									0
	Performance Economy									0
DESIGN	Design for Sustainability			x	x		x		x	3
	Circular Design									0
	Cradle to Cradle Design (C2CD)				x					1
	Social Innovation				x					1
	Design for Social Innovation									0
	Others				x	x				2
		1	2	1	7		1	1		

Table 6: Architecture courses

		Master en Construcción avanzada en la edificación	Máster en representación y diseño en ingeniería y arquitectura	Máster universitario en Ciudad y Arquitectura Sostenibles	Máster en Arquitectura Avanzada, Paisaje, Urbanismo y Diseño	
	INSTITUTION	Universidad Politécnica de Barcelona	Universidad de Málaga	Universidad de Sevilla	UPV Valencia	
TYPE	Master	x	x	x	x	4
	Postgraduate Course					
	Course					
MODE	On-Site	x	x	x	X	4
	E-Learning					
	DURATION	90 ECTS	60créditos	60cr	60 ECTS	
			KATCH_E TOPICS			
ENVIRONMENTAL	Circular Economy					0
	Resource Efficiency					0
	Resource Cascading					0
	Reuse/Repair/Remanufacture/ Recycle	x				1
ECONOMIC	Industrial Symbiosis				x	1
	Sustainable Business Model					0
	Product-Service Systems					0
	Circular Business Models					0
	Performance Economy					0
DESIGN	Design for Sustainability	x	x	x		3
	Circular Design				x	1
	Cradle to Cradle Design (C2CD)					0
	Social Innovation					0
	Design for Social Innovation					0
	Others	x				1
		3	1	1	2	

Table 7 shows the number of appearances of each topic as a specific module, subject or item in the 44 offers studied. In overall, design for sustainability is the most frequent one, followed by the 4Rs and circular economy. Resource cascading, performance economy and design for social innovation are not address, at least by this denomination.

Table 7: Summary of items in the 44 offers

	Reference	Waste	Business	Design	Sustainability	Architecture	**Total**
Circular Economy	3	2	0	2	1	0	**8**
Resource Efficiency	0	0	0	1	1	0	**2**
Resource Cascading	0	0	0	0	0	0	**0**
Reuse/Repair/Remanufacture/Recycle	0	2	0	4	1	1	**8**
Industrial Symbiosis	0	0	0	1	1	1	**3**
Sustainable Business Model	0	0	0	0	2	0	**2**
Product-Service Systems	0	0	0	5	1	0	**6**
Circular Bussiness Models	1	0	0	0	0	0	**1**
Performance Economy	0	0	0	0	0	0	**0**
Design for Sustainability	0	0	1	10	3	3	**17**
Circular Design	0	0	0	0	0	1	**1**
Cradle to Cradle Design (C2CD)	0	0	0	1	1	0	**2**
Social Innovation	0	0	0	1	1	0	**2**
Design for Social Innovation	0	0	0	0	0	0	**0**

Figure 1 shows, for each of the groups of offers, the percentage in which each topic is present. In Reference offers, Circular Economy is the most present subject (60%) followed by Circular Business Models (20%) and others. Regarding Waste courses, Circular Economy, Reuse/Repair/Remanufacture/Recycle and others are present in equal parts. In the business offers, there are contents about Design for Sustainability and “Others”. In the Design offers, the most present topic is “Design for Sustainability” but “Others” is 50% what shows that other aspects about CE, out of the topics considered in this research, are mostly considered.

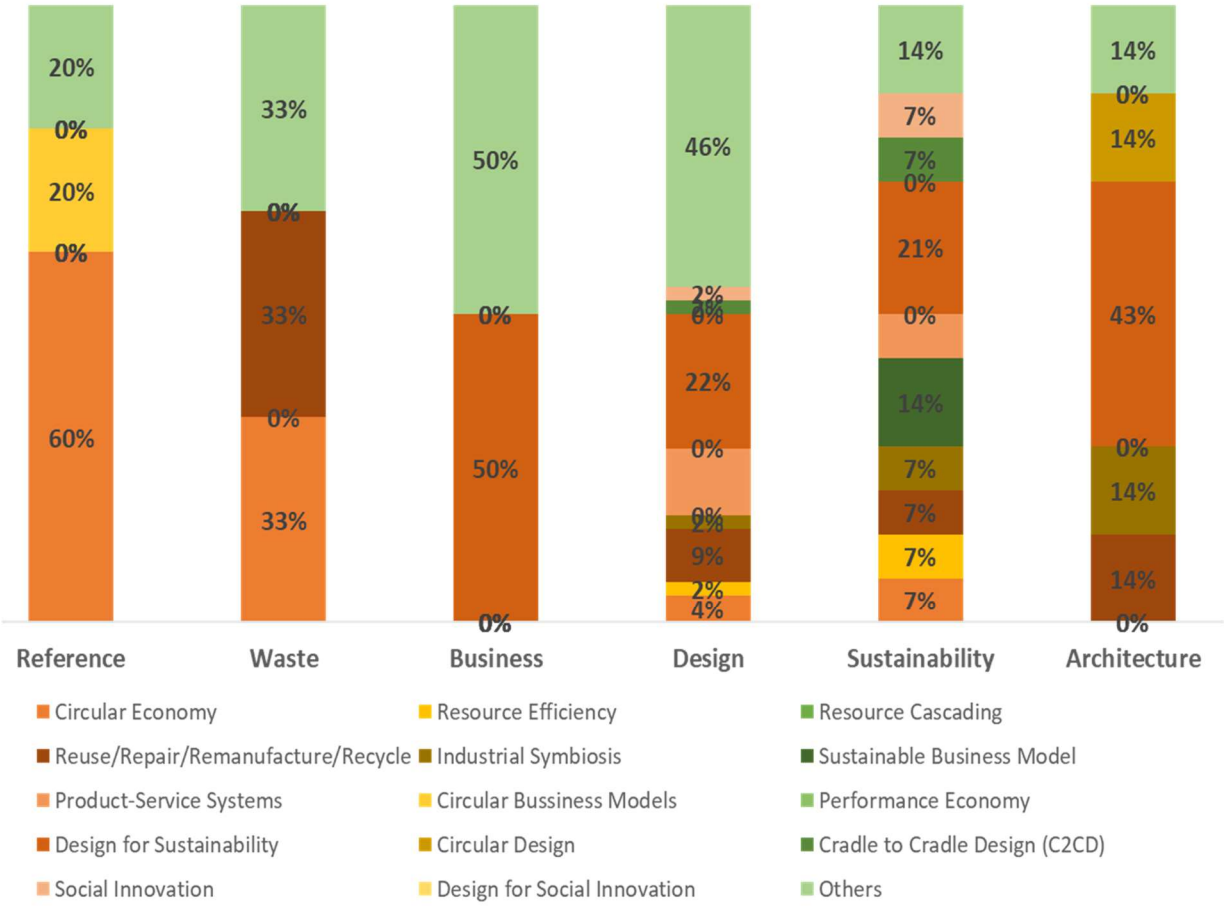
In the Design offers, the most widely analyzed in this study, others are the most present issues, followed by design for sustainability (22%), Product-Service Systems (11%), Reuse/Repair/Remanufacture/Recycle (9%), Circular economy (4%), C2C, social innovation and resource efficiency (2% each).

In the sustainability offers, design for sustainability (21%) is the most common one, followed by Sustainable Business Model, with a 14%. This field is the one that covers more issues:

circular economy, resource efficiency, 4R, industrial symbiosis and PSS, C2C and social innovation.

Regarding Architecture courses, design for sustainability is the most common (43% of the contents related to circular economy), followed by 4R, industrial symbiosis and circular design (14%).

Figure 1: Percentage of topics summary by field of study



5. Conclusion

The implementation of the aspects collected under the CE umbrella in higher education in Spain varies throughout the offers between just one subject and the full master or course. The 3 reference offers talk about Circular Economy concept as a global concept, focusing in detail in just on some aspects of it.

It is necessary to introduce more specific content about circular economy and the concepts that it encompasses, as well as its implementation in the curricula of the areas concerned by the CE. It is needed to improve the training offers in all the aspects covered by Circular Economy, they are present but still in a low way.

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