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DOI:

[10.3390/su131810436](https://doi.org/10.3390/su131810436)

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*Document Version*

Publisher's PDF, also known as Version of record

*Citation for published version (Harvard):*

Palafox-Alcantar, PG, Hunt, DVL & Rogers, C 2021, 'Current and future professional insights on cooperation towards circular economy adoption', *Sustainability*, vol. 13, no. 18, 10436. <https://doi.org/10.3390/su131810436>

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## Article

# Current and Future Professional Insights on Cooperation towards Circular Economy Adoption

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**Abstract:** A circular economy aims to capture the remaining value in waste through several disruptive actions such as reuse, recycle, recover, and regenerate. However, stakeholders in this transition often find themselves in conflict due to their different objectives and priorities. Cooperation is regarded as a critical feature in the implementation of a circular economy; however, it is not easily achieved in practice. Additionally, there is limited research regarding stakeholder cooperation in circular economy development. This paper aims to address this gap by analysing the characteristics of stakeholder cooperation through questionnaire surveys of two stakeholder groups with an interest in the adoption of circular economy principles for municipal solid waste management in Birmingham, UK: 101 MSc students focussing on urban sustainability and 27 businesses engaged in alternative sustainable materials. The paper's primary contribution, being the first to survey participants about perceptions of other stakeholders, has been to gain insights into how stakeholder cooperation is key to facilitating the transition to a circular economy approach. The analysis demonstrated that circular economy awareness, cooperation, and readiness from stakeholders were high, yet their practices do not sufficiently align with this necessary foundation. That said, the study also revealed several encouraging perspectives from stakeholders toward circular economy development, despite benefits and costs not always being evident to all participants.

**Keywords:** circular economy; cooperation; exploratory; municipal solid waste; questionnaire survey; stakeholder



**Citation:** Palafox-Alcantar, P.G.; Hunt, D.V.L.; Rogers, C.D.F. Current and Future Professional Insights on Cooperation towards Circular Economy Adoption. *Sustainability* **2021**, *13*, 10436. <https://doi.org/10.3390/su131810436>

Academic Editor: Elena Cristina Rada

Received: 15 August 2021

Accepted: 13 September 2021

Published: 18 September 2021

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## 1. Introduction

A necessary primary condition for the successful implementation of a Circular Economy (CE) at a city scale is the joint support and continuous interest of all stakeholders [1]. Therein stakeholder cooperation is a vital feature to successfully achieve CE implementation, in particular by overcoming barriers that arise in the design and adoption stages. A cooperative result is less likely to happen unless a third party (i.e., an external authority) is involved and exerts an influence [2]. However, enforcing cooperation is not the only way of improving sustainable performance; indeed, Robèrt and Broman [3] heavily criticise this type of approach through the following misconceptions:

1. We rely entirely on authorities to force trust (cooperation) towards sustainability; and
2. Policy-makers shape law based on this misunderstanding, which results in reinforcing the previous mindset.

The CE concept has been progressively attracting attention from academics, industry, the general public, and governments. Additionally, it has attracted wide criticism; for example, where weak or inappropriate international policies seek to minimise construction waste and increase recycling [4], and of the European Commission CE package which attempts to boost its adoption [5]. Neither example appreciates, nor adequately considers the importance of, stakeholder cooperation as critical to its successful adoption.

Moreover, successful transitioning towards a CE requires a range of guiding principles that form the basis of new (and radically different) business models. For such, the digitalisation and Industry 4.0 combination is an ideal environment in which CE business models can thrive [6]. Implementation of a CE faces a variety of challenges ranging from societal attitudes and practices to governance and the attraction of investors. To overcome these barriers, cooperation among stakeholders is essential, and yet this is proving difficult to attain in practice. Besides, stakeholders each have their own interests and priorities, which often result in conflict [7].

A common belief in the literature of CE obstacles suggests that cultural barriers seem to be more pressing than technological barriers in the EU [8,9]; for example, a large number of surveyed businesses and policy-makers claim that a “*lack of consumer awareness and interest*” and “*hesitant company culture*” are the most prominent reasons hindering the CE implementation [9]. Thus, this research builds upon the “*limited willingness to cooperate in the value chain*” obstacle, which could then lead to obtaining funding for circular business models. This then could enable obstructing laws and regulations to be overcome and the circular procurement processes in government to be improved. Likewise, customers are an essential part of CE, and their awareness is key for implementation; this can (only) be improved with public campaigns, seminars, and educational programs [1].

Many studies assess CE awareness from the general public, firms, government officials, or scholars [10]. Previous research has also focused on revealing the barriers to CE adoption, the CE practices adopted by firms, and general future attitudes to CE development [9]. Another study reviewed the CE peer-reviewed literature using bibliometric network analysis and found that business innovation, waste management, and sustainability are the main research trends [11]. While the relevant literature is discussed in more detail in Section 2, it can be concluded that no individual questionnaire-based study has adequately addressed stakeholder cooperation factors as critical enablers of transitioning toward a CE.

The main objective of this paper is to address this shortfall (no individual survey-based study to comprehensively study stakeholder cooperation aspects as critical enablers of transitioning towards a CE) by conducting a questionnaire survey to gain insights into the stakeholders’ CE awareness and other additional characteristics of cooperation (Section 3). The questionnaire was designed to reveal the insights from two specific cohorts: industry practitioners engaged in the creation and adoption of more sustainable materials (current relevant professionals) and MSc-level university students studying sustainability as part of higher degrees in business, management, and engineering at Birmingham and Oxford Universities (future relevant professionals). This is described in Section 4. The results from the section of the questionnaire dealing with perceptions towards other stakeholders are then compared and contrasted in Section 5 with the outcomes from the game theory-based hybrid tool proposed by the current authors [12]. Along with the insights from the surveys, this provides the main scientific value of the paper. Section 6 crystallises the insights in the form of conclusions and suggestions for how the research might be taken forwards.

## 2. Circular Economy Survey-Based Studies

The most common reason to investigate the awareness (and understanding) of a particular topic or theme is to engender increased use or changes in practice [13,14]. To apply this thinking to CE practices, sustainable consumption and behaviours must be investigated [15]. Studies that try to evaluate CE awareness and stakeholder perceptions and practices related to CE, and hence seek to make the transition towards a CE, remain scarce in the peer-reviewed literature. Thus, the search of CE survey studies was expanded to include what is commonly referred to as ‘grey literature’. To assist in this review, a taxonomy was proposed for the study of the features, or factors, of a CE that would be expected to lead to the achievement of stakeholder cooperation. Presented in Tables 2 and 4, this provides a visual summary of the progress made so far. The purpose of this short review

is to identify and justify the gap in the CE survey-based literature around stakeholder cooperation being an enabler for CE adoption.

### 2.1. Studies of Student Cohorts

To begin the review, a search of the literature using Scopus, Engineering Village, and Google Scholar was performed. Publications that mentioned key terms were filtered using the tools of the search databases, the search strategy for these studies using: TS = (“circular economy” AND student\* AND (survey OR questionnaire\*)). Few results (24) were obtained and only nine of these were found relevant for the review, although most include university students which aligns well with the research reported herein. The one exception was a survey that focused on primary school children (aged 8–12). It was shown that workshops with recycled cans could increase the awareness and intention to recycle of future generations [16]. The rest of the studies focused on university students from different geographies globally (Table 1) and the proposed taxonomy of CE aspects to achieve cooperation is applied in Table 2.

**Table 1.** Summary of previous research based on surveys on student cohorts.

Authors	Application	Region/Country
[16]	Analysed perceptions and practices related to the recycling of aluminium cans.	Spain
[17]	Analysed the perceptions on aspects relating to the siting of new incinerator and landfill facilities.	Campania, Italy
[18]	Explored further such awareness and opinions and recycling practices of the waste produced at home.	Italy, and La Paz, Bolivia
[19]	Surveyed about the effectiveness of active learning procedures when considering environmental and social issues.	Basque Country, Spain
[20]	Asked about the importance of CE topics to their courses and future careers.	Madrid, Spain
[21]	Surveyed about fashion industry trends and their behaviours towards more circular companies	Insubria, Italy
[22]	Enquired on attitudes and practices concerning recyclable waste segregation and collection activities in university campuses.	Bolivia
[23]	Surveyed Massive Open Online Courses (MOOCs) on the use of environmental assessment tools including CE as enablers for improving sustainability.	Spain and Latin America
[24]	Studied the applications of CE techniques to design and develop products.	Spain
[25]	Surveyed current awareness of barriers to, and future prospects of, the sharing economy and related business models.	Russia
[26]	Surveyed attitudes and willingness of the local government to adopting CE principles.	Portugal

**Table 2.** Taxonomy of stakeholder cooperation aspects in the CE transition based on students studies.

Authors	CE Factors Influencing the Ability to Achieve Cooperation							
	Awareness	Waste Behaviours	Activities/ Practices	Barriers/ Drivers	Attitudes	Indicator Preferences	Benefit/Cost Expectations	Perceptions of Others
[16]	✓	✓			✓			
[17]	✓	✓	✓		✓			✓
[18]	✓	✓	✓	✓	✓			✓
[19]	✓			✓	✓			
[20]	✓		✓		✓	✓		
[21]	✓		✓		✓		✓	
[22]	✓	✓	✓	✓				
[23]	✓		✓					
[24]	✓				✓			✓
[25]	✓			✓				✓
[26]	✓	✓			✓			✓

De Feo and Williams [17] measured the knowledge (i.e., their awareness) of *Municipal Solid Waste (MSW)* and then measured its relationship to their opinion (behaviour /attitudes) towards more sustainable MSW treatments. The findings suggested that there is a high correlation between being more aware and having more positive attitudes towards MSW problems. This study also inquired about the opinions of respondents towards a range of stakeholders (e.g., technicians, politicians, citizens) participating in the siting decision-making process of MSW facilities. The results showed that respondents generally accepted that all stakeholders should participate in the decision-making process. Even though it was not the purpose of the study, it did not acknowledge the vast array of CE-related alternatives for incineration and landfill—other than recycling. Furthermore, they only studied differences amongst faculties and course years but did not consider differences between other potential decision-making stakeholder groups.

Ferronato et al. [18] explored awareness and opinion differences between the general public in a developed society (i.e., in Varese and Salerno, Italy) and higher education students in a developing country (i.e., in La Paz, Bolivia). The authors found that while recycling rates remain low in emerging society, nearly two-thirds of the students recycle more than half the waste produced at home. Furthermore, more than half of the students are unaware of the informal sector practices (e.g., scavengers) in terms of recycling. The study did not ask any demographic questions since it was focused on university students, and thus correlations between age and household income were impossible to perform. Besides, further relevant CE aspects were not addressed in the study apart from understanding the recycling practices of the respondents at home.

One article published in conference proceedings concerned a study that involved cohorts of both students and companies. Fonseca and Domingues [26] found that there was high positivity of participants towards '*businesses based on product-service systems to reuse and recycle parts*'. They concluded that more work is needed in designing students' syllabuses to reinforce this perspective, not least because students will become change agents in their future work—moving us towards (or away from) circularity.

## 2.2. Studies of Practitioners and Businesses

Despite its variation in quality, the grey literature contains several relevant conference proceedings, working papers and business, consultant and government reports on CE surveys [27]. The Google Scholar tool was once again used to track down this type of literature as it is sometimes hard to find through traditional search tools (e.g., Scopus,

Engineering Village). The search strategy used the Boolean operators: TS = (“circular economy” OR “zero waste”) AND (survey OR questionnaire\*). The filtered results showed many studies involving companies ( $n = 87$ ), thus the most relevant for this research were reviewed. These are summarised in Table 3, while the cooperation aspects for CE adoption which each studied (Table 4) and their limitations are discussed as follows.

**Table 3.** Summary of previous research based on surveys on practitioners and businesses.

Authors	Application	Region/Country
[9]	Focused on revealing the barriers to CE adoption, the CE practices adopted by firms and general future attitudes to CE development.	European Union
[10]	Assessed the willingness of consumers to be actively involved in closed loops aiming at reducing food waste.	Italy
[13]	First recorded study attempting to measure CE awareness of practitioners. They provided a starting point to develop CE in the region.	Tianjin, China
[28]	Investigated awareness and practices of CE in domestic households, and attitudes of the general public towards the future development of CE.	Urumqi Midong, China
[29]	Measured the CE awareness of officials in six city authorities, and investigated the relationship between CE awareness and enforcement efficiency at the city level.	Northwest China
[30]	Studied public awareness and attitudes towards CE by asking participants to rank areas of CE that affect consumers positively and identify which business activities would benefit most from CE adoption.	Thrace, Greece
[31]	Focused on daily routine and household CE related activities, as well as future expectations on how CE will develop in the region.	Malopolska, Poland
[32]	Studied consumer viewpoints towards CE strategies that attempted to reduce food waste.	Romania
[33]	Asked consumers about their opinions on participating in CE business models for food waste reduction.	Italy
[34]	Established the relationships between awareness and actual practices of small firms to operate under CE principles.	China
[35]	Focused on the main actors in a supply chain (focal firms) to study their awareness, practices and barriers. They also studied how well the focal firms have implemented CE practices or are considering implementing CE practices soon.	Europe
[36]	Evaluated the awareness and actual CE practices of manufacturing companies and their practices embedded in the 3Rs.	UK and Ireland
[37]	Surveyed employees in the biotech and pharmaceutical sectors about their awareness and attitudes towards the firms’ zero-waste-to-landfill strategies.	United States
[38]	Analysed the levels of awareness, challenges to and enablers of CE practices in the construction industry.	United Kingdom

Table 3. Cont.

Authors	Application	Region/Country
[39]	Studied the barriers to adopting CE in the construction and demolition waste management sector.	Iran
[40]	Identified the key barriers and opportunities that prevent or help CE business practitioners to adapt their current 'linear' business to a 'circular' business.	European Union
[41]	Interviewed Gold Leaf member organisations on what they are doing around CE, the opportunities, barriers and solutions and what more UKGBC could do.	United Kingdom
[42]	Measured firms' transversal, sectorial, territorial and governance strategies towards CE transformation	Brussels, Belgium
[43]	Surveyed companies on their barriers and drivers to achieve CE projects.	Tasmania, Australia

Table 4. Taxonomy of stakeholder cooperation aspects in the CE transition based on business and practitioners studies.

CE Factors Influencing the Ability to Achieve Cooperation								
Authors	Awareness	Waste Behaviours	Activities/ Practices	Barriers/ Drivers	Attitudes	Indicator Preferences	Benefit/Cost Expectations	Perceptions of Others
[9]	✓		✓	✓				
[10]		✓	✓		✓	✓		
[13]	✓				✓			
[28]	✓							
[29]	✓	✓		✓	✓			
[30]	✓							✓
[31]	✓	✓			✓			✓
[32]	✓	✓			✓			
[33]		✓	✓	✓	✓			✓
[34]	✓	✓			✓			✓
[35]			✓	✓	✓		✓	
[36]	✓		✓				✓	
[37]	✓		✓		✓			
[38]				✓	✓			
[39]				✓				
[40]				✓				
[41]			✓	✓				
[42]	✓		✓	✓	✓		✓	
[43]				✓				

Liu et al. [13] demonstrated that the older the population, the more sustainable consumption behaviours they have, but the younger population is generally more aware of the new CE paradigm. However, the study was limited to the 3Rs (*Reduce, Reuse and Recycle*) framework, whereas CE implies a broader scope. In addition, the data collection procedures were dubious since a single investigator returned samples of data that were far too large.



Moreover, the design of the survey did not allow for identifying factors that influence pro-environmental behaviours—this can be considered a shortfall in that research.

Guo et al. [28] surveyed in two different periods, 2008 and 2013, to allow comparison of the CE development in the region. The outcomes showed that, on average, the awareness and practices of CE in households had nearly a six-fold increase in five years from 2008 to 2013. However, the analysis could have benefited more from a Likert scale type of response because the questions were limited to only agree and disagree statements. Besides, the phrasing of some questions might have confused respondents; for example, asking respondents if they would be willing to purchase energy conservation appliances only if the government partly subsidises the extra cost.

Xue et al. [29] indicated that the awareness levels are higher in cities where CE schemes and campaigns have been implemented (with up to 79% of respondents being aware of CE). Also, the most pressing barriers to implementing a CE were identified as weak public awareness and the absence of financial support. Despite attempting to gain insights on the performance of promoting CE, the questions were limited to more personal CE actions; for example, home activities or daily routines. Furthermore, the questions about barriers to a CE were designed with an overview of diverse and general areas rather than providing a detailed focus of one specific aspect relating to CE development.

Marios et al. [30] showed that CE knowledge was not the highest amongst the population, but their attitudes and expectations were very positive. However, the study did not provide insights into the respondents' behaviours or current or potential future CE practices that could be adopted.

Smol et al. [31] showed that over three-quarters of the respondents were familiar with the CE concept; however, fewer than half were willing to adopt sharing or collaborative economy principles. The main drawback of this study is that the questionnaire was designed specifically for the case study region; thus, it would need to be adapted, considering local context and conditions, for use elsewhere. Additionally, to effectively evaluate the progress on CE adoption, awareness and behaviours would need to be measured and correlated—these aspects were not considered. Lakatos et al. [32] found high awareness of CE and willingness to adopt CE principles. The focus was only on consumers' attitudes and their sustainable daily behaviour and practices. The study did not address expectations nor perceptions of other stakeholders in the CE transition.

Borrello et al. [10] showed that food consumers are mainly driven by monetary incentives. However, the scope of the study presented respondents with two scenarios from which to choose and did not emphasise cooperation opportunities between households and local governments to reduce municipal food waste. This issue addressed by Borrello et al. [33] showed that the participant most likely to engage with a food-as-a-service business model is someone who has already been involved in CE practices and has developed a long-lasting relationship with the retailers.

Liu and Bai [34] suggested that indeed there is a '*striking gap*' where high levels of awareness are not enough in isolation for transitioning successfully to a CE. However, these authors did not explore further the barriers to why this occurred. Also, one of their questions asked if the interviewees work with other firms to adopt Industrial Symbiosis; however, the analysis was only limited to a yes or no response, thus limiting greatly the information that could have been gained

Masi et al. [35] established the relationship between CE practices with short-term economic enablers. The authors developed taxonomies on barriers and enablers for these focal firms—the output of which was a framework for use in similar case studies. Some of the drawbacks of the study are the small, but sufficient for statistical significance, sample size (77 respondents), which leads to an exploratory rather than definitive study. That said it could be used to help firms better accomplishing their sustainability goals. A more in-depth study on barriers to specific industries, rather than a generic approach, should have been considered, leading to the identification of the triggering factors of adopting CE.



Similarly, Liakos et al. [36] performed an extensive review of CE empirical models and concluded that there is limited empirical research on practices and awareness of CE. The study aimed to test a previous CE model [1] and validated their assumption that the three sustainability pillars are deeply embedded in the CE interpretations of firms. However, most of the responses received came from the UK and Ireland. As most of the manufacturing firms are located in developing countries, a more globalized study would have provided a more valuable insight into the state of play. The main limitation of the study by Veleva et al. [37] was that it focused on non-hazardous waste, but both the biotech and pharmaceutical industries are known for producing highly hazardous waste that needs careful management. The study found that companies focus circular efforts on recycling and waste-to-energy; they also reported inconsistent data on waste and a lack of good indicators on reduction and reuse, and employees were not engaged in the “zero waste” transition and their awareness was underdeveloped.

Regarding more specific industry studies, Adams et al. [38] showed that despite the extensive awareness, the construction industry as a whole is not clear on what CE could represent for the built environment. A significant barrier is that customers, designers, and subcontractors view themselves as the least informed about this transition. The authors identified cooperation in the supply chain as one of the organisational barriers; however, the study did not provide a more in-depth analysis of the factors affecting this. Despite providing a detailed review of the barriers and enablers in the specific construction sector, there were no further questions regarding opinions on other stakeholders in the supply chain. Mahpour [39] categorised 22 barriers into sets: behavioural, legal and technical. Even though the study provided insightful results for the sector, it did not ask about any other of the features required to achieve cooperation towards CE.

Even though the main aim of the publication from Cother [43] was not to measure CE awareness or practices, their findings showed that individual motivation is the prime enabler, while internal resistance, lack of funding, and time limitations are the main barriers.

It became evident that none of the reviewed survey-based studies investigated the role of stakeholder cooperation as an effective enabler of the CE adoption, while a critical analysis of these studies helped in the design of a taxonomy (Table 4) and development of a comprehensive questionnaire survey on stakeholder cooperation to fill this research gap. This paper focuses only on the first (i.e., awareness), third (i.e., activities/practices) and last (i.e., perception of others) CE factors of the taxonomy presented in Tables 2 and 4, because self-claimed CE awareness and actual CE practices are not always correlated to each other, a phenomenon also known as the ‘striking gap’ [34]. Critically, both awareness and practices are assumed to be initial conditions for stakeholders to perceive others beneficially and thus be willing to cooperate, the primary focus of this paper. The relationships with the other factors are out of scope for this paper.

### 3. Methods and Materials

#### *Survey Design and Sample Description*

Several enabling factors can facilitate cooperation between stakeholders; for example, common understanding and interpretations of what a CE is, a clear recognition of what benefits and costs to expect in the transition, and higher levels of trust between participants. The questionnaire survey was designed to study these characteristics, based on the first, third and last categories of the CE taxonomy for stakeholder cooperation in Tables 2 and 4.

There was a basal section that asked about the demographic information of the participants for statistical analysis (see Table 5). The sample consisted of two quite distinct sets of participants: current professional practitioners of CE, and the potential future leaders of industry, academia and government (i.e., future professionals):

**Table 5.** The demographic composition of participants.

ARLI Companies			University Students		
	Number	%		Number	%
Industry sector			Geographic origin		
Education	7	25.9%	China	46	45.5%
Medical	6	22.2%	South and Southeast Asia	8	7.9%
Construction and Land Development	9	33.3%	Middle East	5	5.0%
Agriculture	1	3.7%	Europe	37	36.6%
Manufacturing	4	14.8%	Africa	2	2.0%
Size of organisation			Americas	3	3.0%
1—Independent	2	7.4%	I'd rather not say	0	0.0%
From 2 to 9	6	22.2%	Age group		
From 10 to 49	4	14.8%	18–22	30	29.7%
From 50 to 249	4	14.8%	23–26	53	52.5%
250 and above	11	40.7%	27–30	8	7.9%
Position			31 and older	10	9.9%
Chief Executive Officer	5	18.5%	I'd rather not say	0	0.0%
Director	10	37.0%	Gender		
Project Champion	7	25.9%	Female	34	33.7%
Manager	5	18.5%	Male	67	66.3%
Time in position (years)			Other	0	0.0%
Average	7.59		Programme of study (University)		
Minimum, Maximum	1	32	Engineering and Management (Birmingham)	88	87.1%
Standard Deviation	8.29		Business Management (Oxford)	13	12.9%

- Companies involved with the Alternative Raw materials with Low Impact (ARLI) project (The ARLI project is an ERDF-funded project whereby a team of experienced academics and engineers support businesses in developing cost-effective products and processes that provide energy-efficiency gains in the use of raw and waste materials. The CE-based project, delivered through the School of Engineering at the University of Birmingham, UK, aims to identify waste streams or other materials that could be transformed into higher-value goods for construction and other manufacturing industry applications—<https://www.birmingham.ac.uk/partners/sme-support/business-support-programmes/arli.aspx>. Accessed on 16 September 2021) at the University of Birmingham ( $n = 27$  out of approximately 145). These are companies with a professional interest in the general topic area covered by CE.
- Post-Graduate Masters level students from:
  - University of Birmingham (students opting to study Sustainable Construction as part of their degrees in Engineering, Business and Management,  $n = 88$ );
  - University of Oxford (Business School,  $n = 13$ ).

The first group represented 27 (out of ~145) Small and Medium Enterprises (SMEs) from the West Midlands area in the UK. This constitutes an 18.6% return rate, which compares favourably with completion rates of around 10% reported in previous web-based survey studies of industry participants [44]. The firms are involved in the ARLI project, which supports local businesses in developing products and processes to leverage the use of raw or waste materials. Thus, these companies had already been directly involved in CE practices.

The second group were postgraduate students ( $n = 101$ ), consisting of 13 students from a Business Master's course (University of Oxford), and 88 MSc students taking the Sustainable Construction module run by the School of Engineering (University of Birmingham). The linking thread between them is that the programme in Birmingham is heavily linked to the Business School, thus the full cohort comes from a range of different backgrounds but all with a focus on business (of which CE could be a key business case driver) and management. The survey was performed before the lecture on CE, and therefore

neither group had greater prior knowledge of CE. They can all be described as students who had a genuine interest in this topic, before them studying it in more detail. Due to the exploratory nature of the study and the small but high-quality sample, the analysis involved mainly simple statistics.

To incentivize the voluntary participation of businesses respondents in the survey, a small gift (a printed copy of the “*Little Book of Circular Economy in Cities*” [45]) was offered as a gesture of appreciation. For the Birmingham students, 5% of their final module mark was allocated to the survey, the mark awarded being solely related to the diligence with which the students completed the survey. The survey took place over two months (between March and May 2021). The questionnaire consisted of three sections:

Section 1: To identify respondents’ familiarisation with the CE (Table 6).

Section 2: To learn about the importance respondents attached to adopting CE principles (Table 7).

Section 3: To gain insights into respondents’ perceptions of other stakeholders (Table 8).

**Table 6.** Questions on stakeholders’ awareness of CE.

No.	Question (Q)	Choices for Question (Ai)	References
Q1.1	How well do you understand the concept of ‘circular economy’?	(Very well) 5; 4; 3; 2; 1 (Not well at all); Never heard of it	[42] (p. 11)
Q1.2	Do you agree with the following statement . . . ? <i>The ‘circular economy’ is just another word for reducing, reusing and recycling materials.</i>	(Strongly agree) 5; 4; 3; 2; 1 (Strongly disagree)	[41]
Q1.3	Which of the following concepts are important to the ‘circular economy’?	Close material loops; Reduce; Reuse; Recycle; Systems thinking; Renewable energy use; Build resilience; Design out waste; Share resources; Increase exchange	[36]

**Table 7.** Questions on the importance of adopting CE principles.

No.	Question (Q)	Choices for Question (Ai)	References
Q2.1	How important is adopting circular economy principles to your discipline/industry?	(Very important) 5; 4; 3; 2; 1 (Not important at all)	[13,16,31,34]
Q2.2	What do the components from the waste generated in your discipline represent to you?	Discards to dispose of in landfill; Materials to recycle; Waste to incinerate; By-products valuable to others; Hazardous materials to manage carefully	[17,18]
Q2.3	Which of the following do you think would be strong motivators to transition to a more circular economy approach?	Limited resource supply; Increasing of future profits; Sustainable business strategy; Entering new markets; Public opinion; Energy savings; Fluctuating resource prices; Enforcements by law; Keeping up with competitors; Reduce waste; Avoid landfill; Decrease costs	[29,38,40]

**Table 8.** Questions on respondents' perceptions of other groups.

No.	Question (Q)	Choices for Question (Ai)	References
Q3.1	Do you agree with . . . <i>It is essential to trust other stakeholders and disciplines when cooperating in the implementation of circular economy principles</i>	(Strongly agree) 5; 4; 3; 2; 1 (Strongly disagree)	[31]
Q3.2	Who among the following actors needs to cooperate when adopting CE principles in the new waste management strategies in the city?	Researchers; Private investors; Entrepreneurs; Local politicians; Local policymakers; Local authorities; Academic institutions; Waste management operators; Technology suppliers; Local inhabitants/citizens; External consultants	[18]
Q3.3a	Which stakeholders are the most/least powerful in the circular implementation process?	(Most) 5; 4; 3; 2; 1 (Least)	This question aims to compare the results with the <i>Shapley Value</i> results in [12]
Q3.3b	Is their power increasing, decreasing or staying the same?	(Increasing) 5; 4; 3; 2; 1 (Decreasing)	

The survey was distributed via email through a link to the electronic version in the “*Jisc online surveys*” platform. Two reminders, each one month apart, were sent to potential participants to encourage them to take part. Ethical approval was obtained from the University of Birmingham Ethical Committee to ensure the participants' confidentiality (ERN\_19-0203A).

Table 6 presents the questions posed in relation to stakeholders' awareness of CE, their possible responses, and references. The first question was adapted from [42] (p. 11) by improving the scale of the original question. The second question was improved from that of [41] by including the “reducing” option to study how deep the well-known 3Rs (reduce, reuse, recycle) are embedded in the interpretation of CE from respondents. The third question was taken from [36] to directly assess the respondents' (self-reported or perceived) view on the most important concepts that form part of CE awareness.

The second set of questions analyses how the participants identify the importance of a CE to them as individuals (see Table 7). The first question focused on the importance of CE for the students' disciplines and organisations' work, complementing investigations into the public's attitude towards the future of CE and its development [13]; and local inhabitants' opinions on the development of CE in their region (Malopolska, Poland) [31]. The second question was adapted from [17] by including the last three answer options to respondents. The third question was based on previous work on CE enablers and opportunities [40], the enablers/drivers of CE in the construction sector [38], and the perceived best methods to push CE development [29].

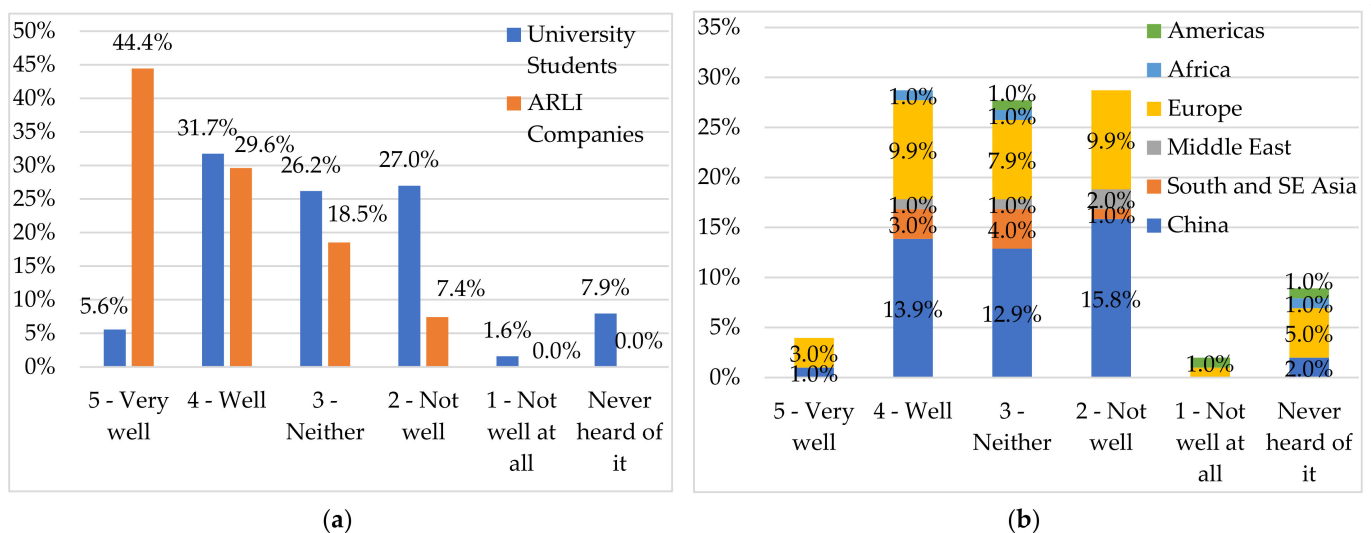
The third section of the survey attempted to gain insights into the respondents' perceptions of other stakeholders (see Table 8). There is no similar question in the literature to the first question, which was designed to measure the respondents' level of willingness to cooperate. The closest correspondence was perhaps the questioning of respondents on the reasons for not sharing journeys or renting properties directly from owners [31], and the most selected response was due to the lack of trust between participants. The second question was improved from [17] by introducing several more options and expanding the question to “*new waste management facilities*” rather than only the “*landfill and incinerator*” options given in the original article.

Questions Q3.3a and Q3.3b were newly defined for this research. They aimed to compare the results with the *Shapley Value* outcomes from Step 6b at the end of the game-theory-hybrid tool in [12]; more details are provided in Section 5.

## 4. Results and Findings

### 4.1. CE Awareness

The first characteristic studied was stakeholders' levels of CE awareness. The first question therein, Q1.1, was used to assess whether participants were familiar with the term 'Circular Economy'. The results validated the hypothesis that most of the participants (both students and companies) were aware, to some degree, of the CE concept. This is further explained by Figure 1 showing that nearly half (44.4%) of the business respondents were very familiar with the concept. This was as expected since they participated in the ARLI project, as opposed to students of whom only 5.6% understood the concept 'very well'. Approximately one-third of the students understand the CE well (31.7%) or very well (5.6%) and only a small portion (7.9%) had never heard of it before the CE lecture/course. Most of the students came from either China or Europe, and they were the ones most familiar with the CE concept, whereas students from Africa and the Americas were more likely to have never heard of or be unfamiliar with the term.



**Figure 1.** Q1.1—(a) CE awareness of respondent groups; (b) Geographic origin of students.

The aforementioned '*striking gap*' assumes that awareness is not enough to implement CE. In this study, the participants claimed to have a high awareness of the CE term before—however it is well reported that developing CE behaviour does not depend solely on increasing the awareness of CE [14,34].

Q1.2 assessed by how much the stakeholders' interpretation aligns with the 3Rs concept; a contested and arguably limited understanding of what a CE truly is about [34]. The results in Figure 2 show the diversity of responses: around a third of both cohorts respondents (35.7% and 37.0% respectively) disagreed with the statement, while around a third of them (34.1% and 33.3% respectively) would describe CE '*very similarly*' to the 3Rs concept, and only 18.5% of the companies would not describe CE as only reducing, reusing and recycling. Again, this shows the companies' strong familiarisation with the CE concept due to being directly involved in the ARLI project.

Liakos et al. [36] asked their respondents to rank how much they agreed that a CE is essentially the 3Rs (Q1.2), with around two-thirds disagreeing with the statement. Only a third of respondents were aware of what the 3Rs stood for and agreed that they adequately represent CE [34]. This current research validates both of these findings—with 39.7% of students and 37.0% of company respondents' agreeing respectively to CE being just another buzzword for the 3Rs concept. This might be caused by the 3Rs being the critical association between the environmental and financial aspects on the more technical side of a CE [36].

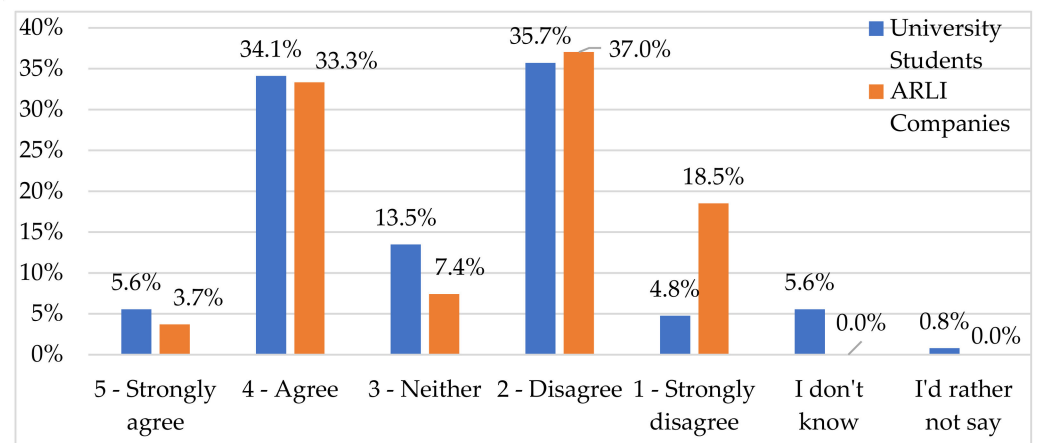


Figure 2. Q1.2—CE and the 3Rs concepts alignment from participants.

Figure 3 presents the results from Q1.3, the main categories of CE research and practice selected from different studies [17,18,30,31]. The first observation is that the 3Rs are embedded in the interpretations of both groups of respondents. The “Design out waste”, “Share resources” and “Increase exchange” responses were selected more frequently by the industry respondents. The least identified category was “Build resilience” with a selection rate of 49.2% for students and 48.1% for companies, these percentages being less than the value of 69% reported by Smol et al. [31].

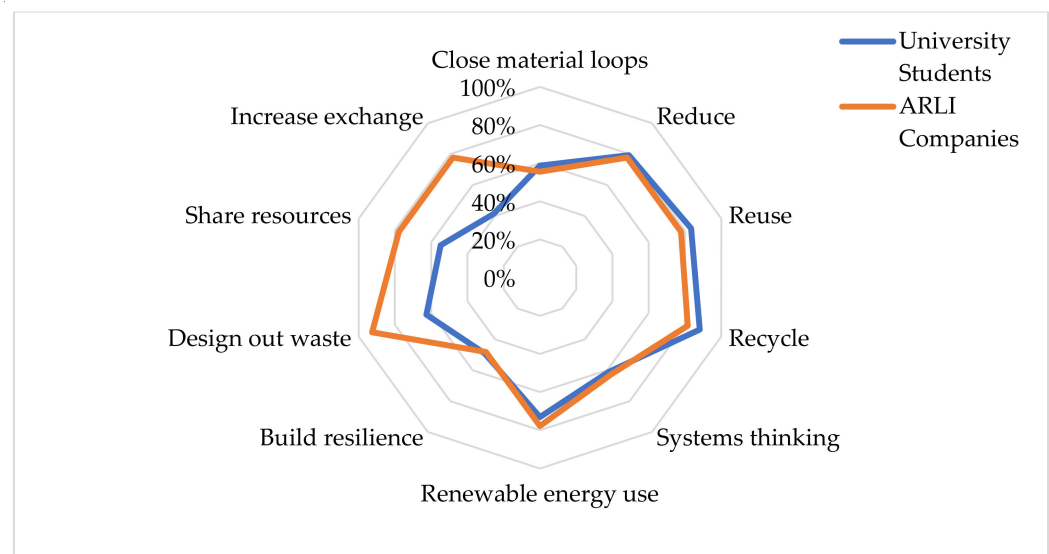


Figure 3. Q1.3—Categorisation of the most important concepts of CE by different stakeholders.

This question was asked to expand upon the answer to the previous question (Q1.2), participants being provided with several categories and asked to select those to which a CE aims to contribute (Q1.3). Previous research [31] suggested that more than three-quarters of the general public think that the critical characteristics of CE are related to protecting the environment and minimising losses from waste streams. This current research found that most of the participants’ opinions were aligned with environmental responsibility; around 75% of respondents were concerned about renewable energy. This research also found that around half of participants (55%) also identified CE’s potential to close material loops.

#### 4.2. Importance of Adopting CE Principles

The second section of the questionnaire aimed to learn about the respondents’ attitudes towards and the perceived importance of adopting CE principles. The first question, Q2.1,



revealed the importance of embracing CE to the companies and disciplines of the students (Figure 4). There is a clear trend: respondents consider embracing CE as (at least) an important asset to their spheres of operation. For companies, 51.9% selected ‘important’ and 37.0% selected ‘very important’, whilst for students, 97.6% (difference of +9%) considered CE as either important or very important to the future of their disciplines and careers. None of the participants thought that CE was not important at all.

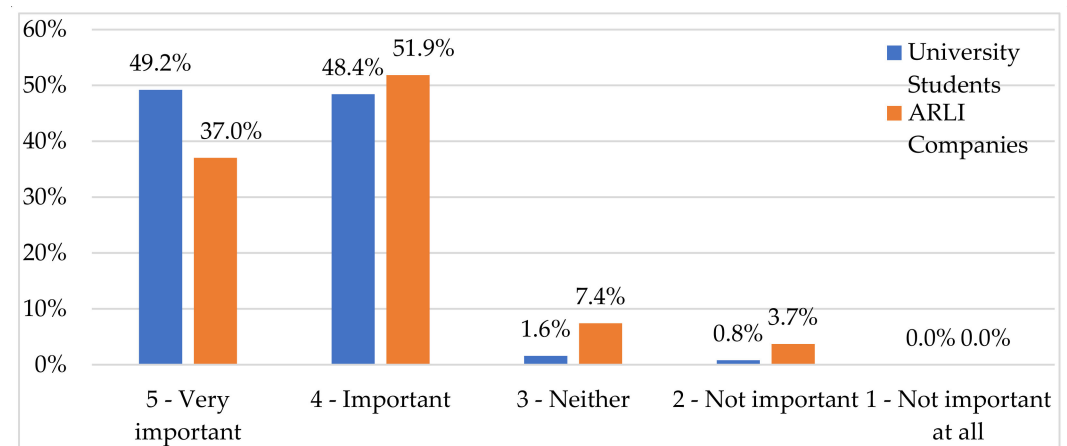


Figure 4. Q2.1—Importance of adopting CE principles in disciplines/organisations.

Similar to the focus of this question, respondents in other research [13], when asked about their attitudes toward household waste separation and shared-product services, indicated that over half of the local population was interested (and committed) to separate their waste at home to achieve the CE objectives of local government. Another study [31] surveyed the confidence of respondents regarding successfully developing a CE, the results showing that more than 80% of the respondents perceive that a CE is achievable and were in favour of its implementation in the region. However, it was recognised that a long-term planning process and additional financial support would be needed. Both of these studies support the results from this current research, in which it was found that nearly 90% of company respondents identified the development of CE as at least ‘important’. Few respondents viewed CE as neither important nor unimportant, however, participant A-024 stated that: “adopting CE is not the main concern in the development (of the firm), but certainly presents a unique opportunity to apply it as an unintended side effect”.

The second question from this section, Q2.2, asked about the meaning of general waste to respondents. It can be observed from Figure 5 that students believed that waste can be dealt with in significantly more alternative ways than companies. As expected, the option most selected by both cohorts is recycling with 90.5% and 74.1% respectively for students and companies. A landfill was the least preferred option (3.7%) for companies, significantly less than students at 46.8%, while incineration was likewise considered a more likely outcome by students (44.4%) than companies (22.2%); these findings possibly reflecting a lack of awareness amongst students of the costs involved.

These results are highly consistent with findings in the literature. In this study, the options ‘Discards to dispose of in landfill’ (46.8% and 3.7%), ‘Materials to recycle’ (90.5% and 74.1%) and ‘Waste to incinerate’ (44.4% and 22.2%) were provided to the respondents. The difference between cohorts regarding the attitude towards landfills is remarkable. Similar responses within the literature received 6.3% for landfill, 77.6% for recycling and 4.1% for incineration [17], while respective response rates of 9.5%, 70.3% and 13.1% were recorded by Ferronato et al. [18]. This research included two additional options: ‘By-products valuable to others’ and ‘Hazardous materials to manage carefully’. The first option was used to expand the understanding of CE (in line with Industrial Symbiosis practices) and received a high number of responses (63.5% and 44.4%), where the waste generated by the industry is

potentially an input for another industrial process. Only 22.2% of companies selected hazardous materials to manage carefully (e.g., medical waste) as a waste component.

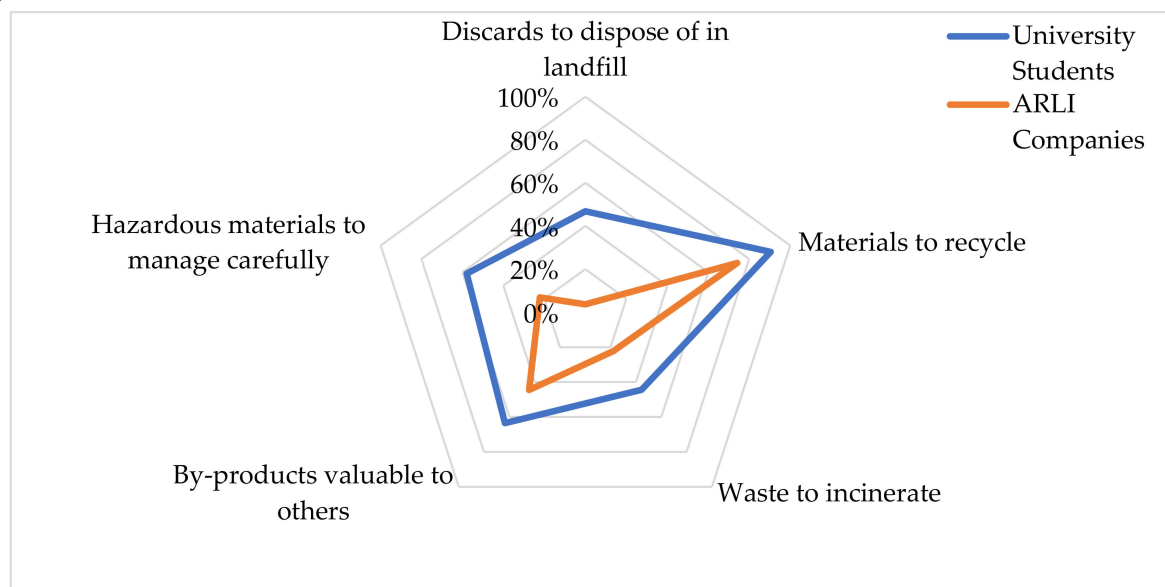


Figure 5. Q2.2—Meaning of waste components to participants.

The results for the final question of this section, Q2.3, which asked about the main enablers of the successful transition to a CE, are shown in Figure 6. Herein it is observable that students once again have on average a higher opinion of the options provided (excepting ‘avoid landfill’). Students have selected the ‘Sustainable business strategy’, ‘Energy savings’ and ‘Reduce waste’ options as the most important (with 84.9%, 79.4% and 74.6% respectively), whilst ‘Avoid landfill’ and ‘Fluctuating resource prices’ were the least important (with 37.3% and 30.2%). On the other hand, ARLI companies’ responses aligned strongly with the ‘Sustainable business strategy’ being the first enabler to a CE (with 63.0%), whereas the choices with the lowest response rates were ‘Fluctuating resource prices’, ‘Entering new markets’ and ‘Keeping up with competitors’ (with 25.9%, 22.2% and 18.5% respectively).

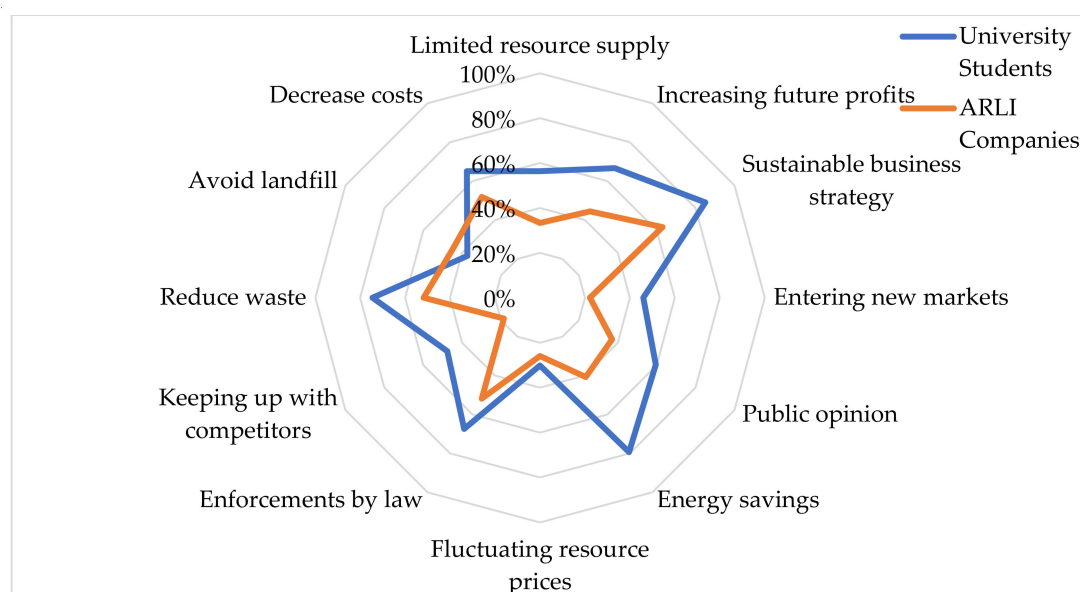


Figure 6. Q2.3—Motivators to encourage the transition to a CE.

It was reported above that over three-quarters of the general public think that the critical characteristics of CE are protecting the environment and minimising losses from waste streams [31], while this research found 93% of participants' opinions to be aligned to environmental responsibility. On the other hand, from the consumers' viewpoint, CE was generally perceived by 69% of respondents as a new sustainable business model [31], a finding that compares favourably with 84.9% and 63.0% of participants (students and companies respectively) viewing the CE as such (i.e., under 'Sustainable Business Strategy') and 66.7% and 44.4% identifying its potential for boosting economic growth (i.e., under 'Increasing future Profits').

#### 4.3. Perceptions of Other Stakeholder Groups

The first question in Section 3, Q3.1, explored the level of trust needed between stakeholders (Figure 7). The results show a strong agreement for the need for stakeholders' mutual trust if they are to cooperate and successfully adopt CE principles (with 90.5% of students and 77.8% of companies at least agreeing). Few of the responses disagreed, although participant C-018 stated that "one cannot trust SMEs to do what they have to do; we really need to chase them". However, other responses were more optimistic: for example, participant A-013 said that "these things are not by chance—they take hard work, effort and trust. It implies the definition of joint-venture, the need to put things in a legal matter, so everyone gets clearly what to do and what to expect".

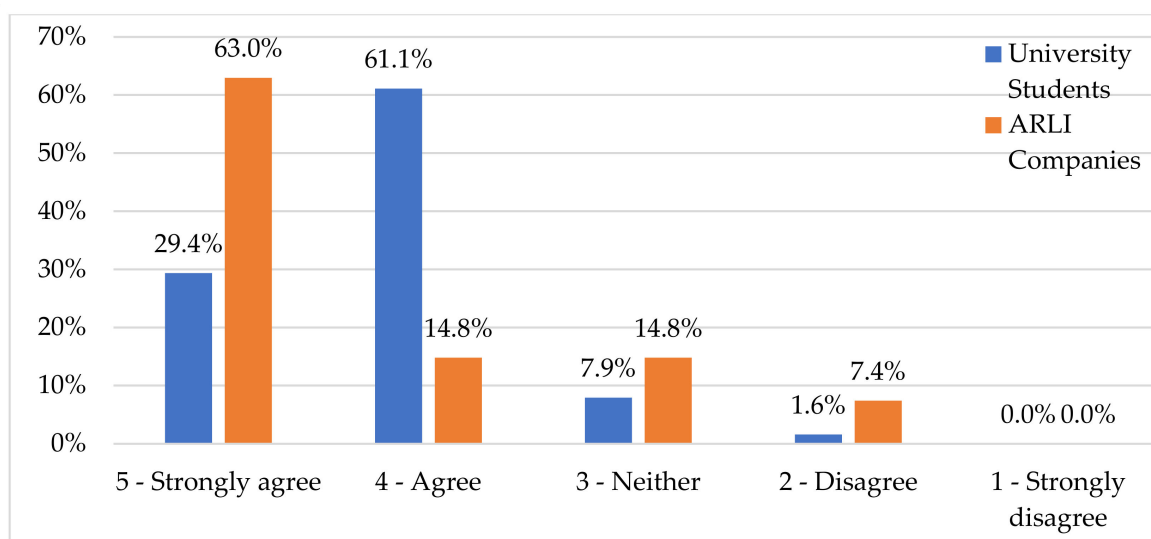


Figure 7. Q3.1—Agreement of respondents to the need to trust other stakeholder groups.

While this survey found the need for trust between stakeholder groups to be vital in CE transitioning, and that any CE project should make explicit what the participants can expect to obtain and to contribute—underlined by mutual (perhaps legislated) trust—within the literature the only question that previously addressed a trust issue revealed that the main reason for not using a 'sharing' business model was the lack of trust between users themselves [31].

Figure 8 shows the results for Q3.2, which asked which actor(s) need to cooperate and therefore should be involved in the decision-making processes associated with new CE waste management strategies for the city. This complemented previous surveys that asked respondents about the levels of CE awareness and participation of a range of participants within the construction sector [38] and found that despite the extensive awareness, the industry as a whole was not clear on what CE could represent for the built environment. Other research [17,18] posed questions about how many local residents are (or should be) involved in new waste management policies.

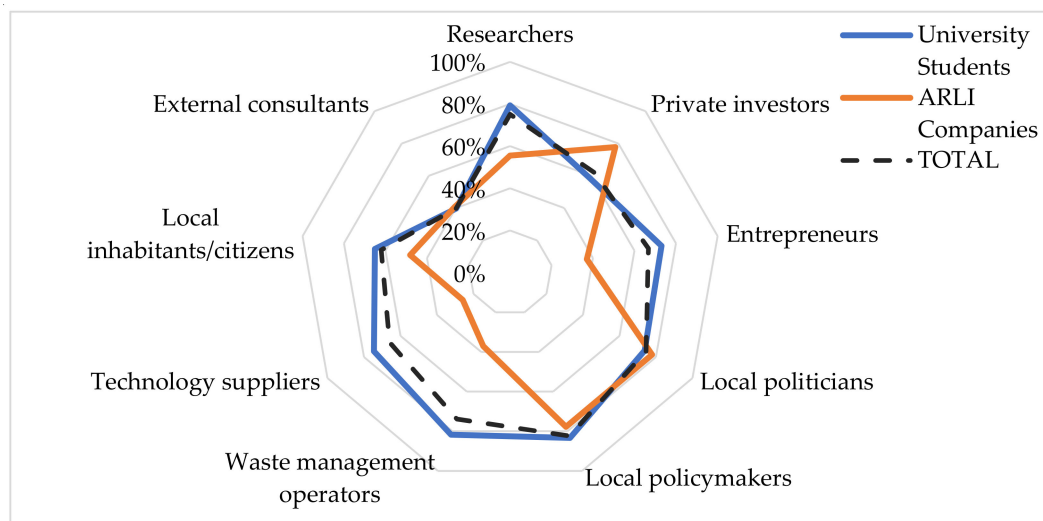


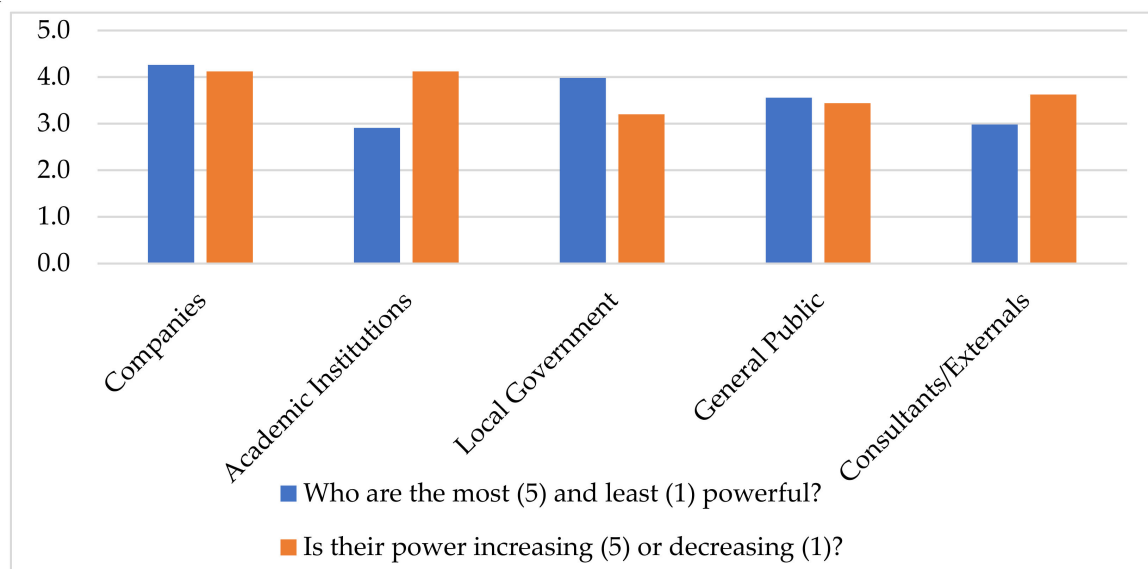
Figure 8. Q3.2—Opinions on actors who need to cooperate when adopting CE in urban waste management.

In this current research, the actors who received the higher number of total responses were Local politicians (with an average of 75.8%) and Local policymakers (80.6%). External consultants were considered least important (with only 40.2% of the total responses), followed by Technology suppliers (66.0%). The largest differences between cohorts' viewpoints were for Technology suppliers (with 74.6% and 25.9% respectively for students and companies), followed by Waste management operators (with 81.7% and 37.0% respectively) then Entrepreneurs (73.0% and 37.0%).

Results of this question show that Private investors, Local politicians, Local policymakers, Local inhabitants/citizens and Technology suppliers received the highest number of votes by total respondents. This is therefore comparable with the outcomes from recently-published research [17,18] in which nearly 59% of respondents agreed on including all of the actors asked (technicians, politicians and citizens). However, these papers did not include the wider range of options available in this research (Researchers, Private investors, Local policymakers, Entrepreneurs and Consultants).

Figure 9 shows the results for the last question, Q3.3, on how respondents, in this case, the ARLI companies alone, perceive the power and power trends of stakeholder groups. The results will be compared and contrasted with the results from the Shapley value method [12] in Section 5. The most powerful stakeholders, i.e., those most able to bring about the transition to a CE, were deemed to be Companies (4.26) followed by Local Government (3.98), with Academic Institutions perceived to be the least influential of them all (2.91). As to the power of the perceived trend (with increasing power scored as 5 and decreasing scored as 1), Companies and Academic Institutions were both recognised as becoming more powerful (and therefore influential), the latter perhaps because of a renewed tendency, at least in the UK, to 'follow the science'. On the other hand, the Local Government was considered to have decreasing power/influence in the CE transition whereas the perceived power of the General Public was considered to remain relatively unchanged. As stated by participant A-013: "the government has been struggling with budget cuts and the private sector and academy are filling those gaps".

A previous study [18] asked how readily local government involves local citizens in the MSW policy-making process. Their results showed the government to be good at including citizens through recycling campaigns and waste reduction programmes in schools, however, citizens often felt excluded when it comes to selecting new waste management policies. The outcomes from this current research agree with those results, particularly where the responses between the Local Government and General Public show their mutual readiness to cooperate in decision-making about CE adoption.



**Figure 9.** Q3.3—Perceptions, by companies, of power and trends of stakeholders' power in the CE transition.

These last three questions aimed to gain insights on specific aspects of cooperation with other stakeholder groups. This proved to be a relatively unexplored area within the literature with the notable exception of the work of Liu and Bai [34], who asked their respondents if they already cooperated with other companies in eco-industrial chains; their results showed that only slightly over 10% of respondents did. This may be because, as shown in this research, companies are viewed as less trustworthy and do not always appear to share the objectives and goals of the rest of the stakeholders. Nevertheless, as this research has also shown, it should be recognised that Companies are crucial actors in this sphere of activity, both due to their proactive approaches towards adopting CE and the power of their perceived influence.

Local Government is seen by all respondents as a critical, trustworthy and proactive stakeholder in the CE transition, while also sharing the goals and objectives of other stakeholder groups. In contrast, the General Public is perceived (in general) as having the weakest of these characteristics; this contrasts with them being the group who are key in the demand for CE change [18]. This is explained by one of the major underlying challenges: the local population must become more aware and demand these changes to happen on the ground [46].

In summary, there are only a small number of results available from the reviewed articles to compare with those from this work, and the literature does not explicitly address the perceptions of other stakeholders in the CE transition. This work attempted to provide the first insights into this, the results showing that stakeholder groups are usually ready to trust each other and cooperate to facilitate the CE adoption. This is a positive result in moving towards achieving CE status.

## 5. Discussion

### *Perceptions of Other CE Stakeholders*

The questionnaire in this study explored the willingness to trust other stakeholder groups in the CE transition. The only question in previous studies that addressed a trust issue [31] revealed that the main reason for not using sharing business models was the lack of trust between users themselves. The ARLI companies (only) were asked to express how powerful in this CE transition they viewed other stakeholder groups (Q3.3a). An extended analysis of these questions is discussed hereafter.

These results compare with the Shapley value results from the game theory-hybrid method (see [12]), as displayed in Figure 10. The primary (left) axis shows the benefit allocation for the Shapley value results (Figure 6 in Palafox-Alcantar et al. [12]). It is

worth reiterating that the definition of the Shapley value is the allocation of benefits to each stakeholder, according to their contribution to the coalition. The secondary (right) axis shows the power index which represents (in terms of percentage) how stakeholders perceive the power/influence of each other. As observed, Companies were perceived as the most powerful/influential stakeholder group. However, previous results also showed them to be the least benefitted in the decision-making process. Academic Institutions, in contrast, were expected to be the least influential, but they are the second most benefitted group in the Shapley value assignment. In line with the literature, local government is generally seen as the key stakeholder expected to drive the CE transition [17,18,29]. Local government is rated as the second most influential stakeholder, and the Shapley value results show that it is the stakeholder with the most allocated benefits; thus, they should, in theory, take a lead in engendering cooperation amongst the rest of the participants.

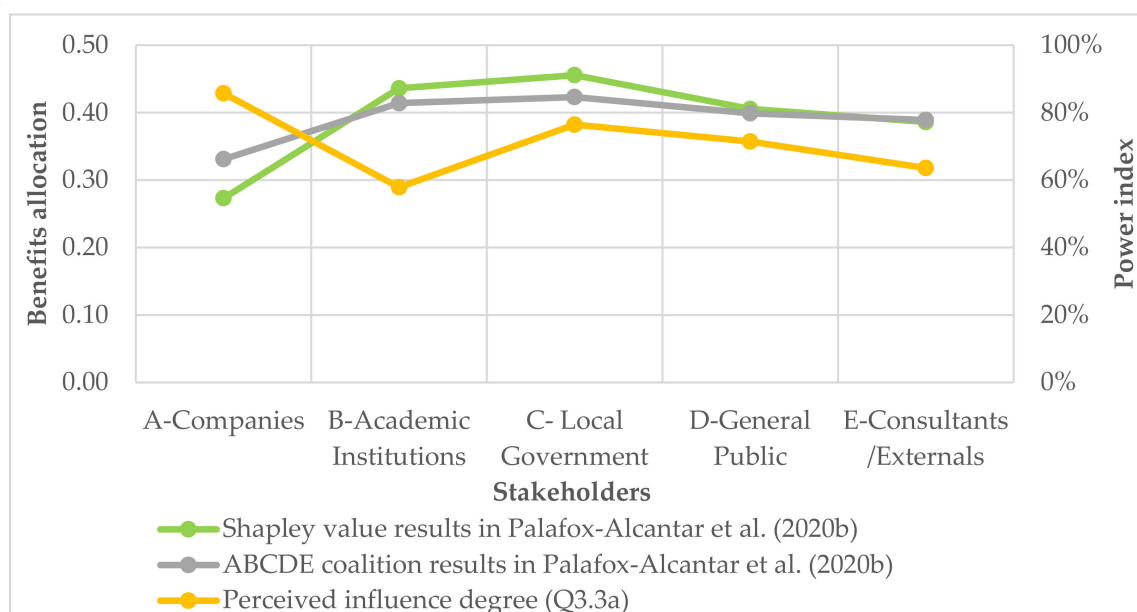
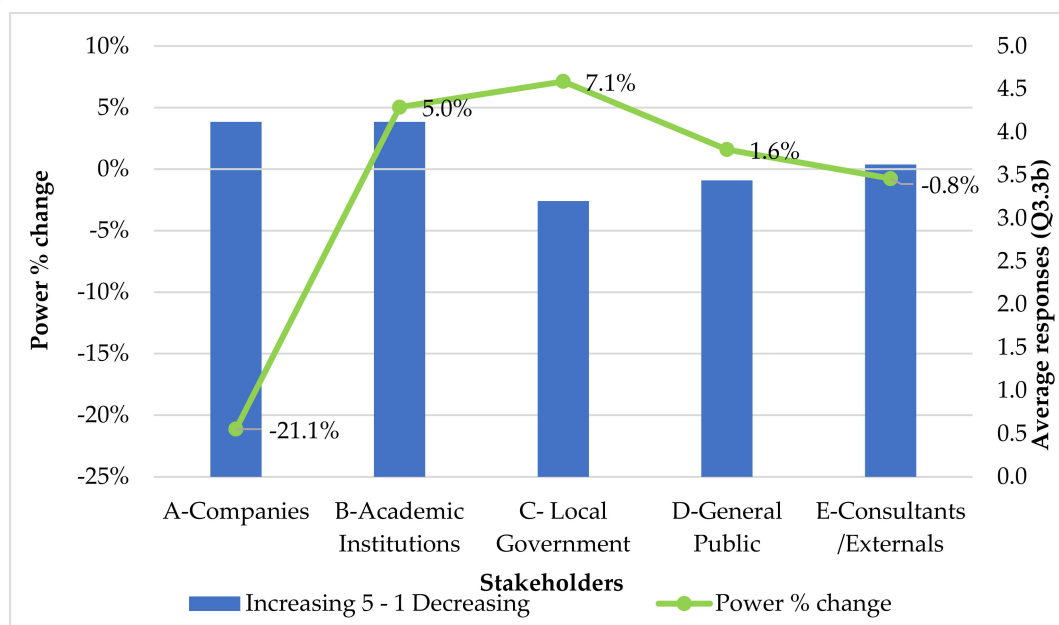


Figure 10. Comparison of the perceived influence of stakeholders (Q3.3a) and Shapley value results in [12] (p. 25).

Figure 11 shows the opinions of whether the stakeholder's influence is increasing, staying the same or decreasing. The primary (left) axis represents the % change in power or the change from the original ABCDE coalition to the suggested Shapley value coalition (see Figure 10 and [12]). The secondary (right) axis represents the average results (based on a five-point scale) regarding the trend of each group's influence (see Q3.3b). As observed, Companies were considered to have an increasing trend in their influence. However, the Shapley value results suggest that their final power (i.e., benefits allocation) might be decreased in this particular case. This is to increase the benefits allocated to other stakeholders and to achieve cooperation so that all stakeholders choose the most sustainable scenario (for more on this refer to [12]). Academic Institutions were considered to be more influential over time, and the Shapley value results show that their power will increase (by 5.0%). The local Government also can increase their power (by 7.1%). Consultants/Externals were thought to have increasing influence, but the results show their power would slightly decrease (−0.8%) with the suggested Shapley allocation. The General Public is thought to retain a similar power in the CE decision-making process, and the results show that their power could also be slightly increased (1.6%) in this particular case study.





**Figure 11.** Comparison of the perceived trend in influence and power change percentage (Q3.3.b).

Q3.3b also addressed the effects on stakeholders being affected by the CE transition. Previous work explored only how the CE transition would affect a group [30]. Their results showed that respondents view a CE as a positive change to reducing waste generation and improving the environmental consciousness of the public. The outcomes of this work showed that all stakeholders are positively affected by the transition to a CE, with some being also negatively affected. For example, Companies would welcome the opportunity of developing new business models, but they often must accept significant risks and costs; Governments face these challenges usually under the pressure of budget cuts; the Local Inhabitants need to become yet more informed and aware of these changes.

In summary, even though there are a few results from the reviewed articles available to compare with those from this work, the literature does not explicitly address the perceptions of other stakeholders in the CE transition. This paper provides the first insights into this; the results showed that stakeholder groups are usually ready to trust each other and cooperate to facilitate CE adoption.

Such cooperation would be greatly enabled by the adoption of a systemic approach to understanding the aspirations of each of the stakeholders [47], designing a waste management operating system that meets the collective aspirations of the stakeholders, and then creating suites of alternative business models that provide options for the stakeholders to realize their intended beneficial outcomes [48]. The systematic approach—founded on mapping the system of interest in relation to all other urban systems with which it is dependent or interdependent—ensures, as far as is possible, that the outcomes from the waste management operational system are comprehensively, transparently and accessibly articulated. This articulation will, in turn, strengthen the trust between the stakeholder groups and help ensure that a cooperative and collaborative approach to waste management persists and undergoes progressive refinement.

One final consideration, building on this trust between the various stakeholders and willingness to cooperate, hence collaborate, is the need collectively to understand all of the forms of governance affecting the system of interest—the waste management system—both formal and informal. The formal forms of governance (i.e., legislation, regulation, codes and standards, taxation and incentive schemes) are relatively straightforward to identify, whereas the informal forms of governance—individual and societal attitudes and behaviours, social norms, practice norms—and the mechanisms available to positively in-

fluence them, are less clear. Here it is important to understand the links between awareness, perception, attitudes and behaviours, as described in [14].

The systemic approaches to stakeholder identification and engagement, understanding collective aspirations, designing operational (in this case, waste management) system change, testing it against current system performance (e.g., using sustainability assessment frameworks) and likely future contextual change (to build in resilience), co-creation of a suite of alternative business models that enable the stakeholders to realize the potential benefits offered by different operational designs, and alignment with all (formal and informal) forms of governance that would determine whether the business models would work and deliver their intended benefits are all being advanced by the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC—see [www.ukcric.com](http://www.ukcric.com). Accessed on 16 September 2021). The findings of this research impact the very start of this process of making positive change happen.

## 6. Conclusions

The main objective of this paper was accomplished by being the first to develop a taxonomy for factors that influence stakeholder cooperation based on surveys literature related to the Circular Economy (CE). Second, the paper performed a literature-based survey to measure CE awareness and study other features of CE stakeholder cooperation, most importantly the perceptions of respondents towards other stakeholders. The study then applied the questionnaire and tested its effectiveness by comparing and discussing its outcomes with the existing literature, and added to its scientific value by contrasting its results with those from the game theory hybrid method proposed by the current authors [12].

The following conclusions can be drawn from the findings:

- Studies based on surveys in the CE literature are usually limited to measuring CE awareness amongst government, the general public and firms. Other aspects are commonly researched, such as barriers, enablers, practices and attitudes; however, the relationships with cooperation have not been sufficiently explored.
- The 3Rs approach is still ingrained in the CE practices of respondents. Whilst this is not a negative symptom, it reinforces the ‘striking gap’ between the self-claimed awareness of the CE and the practices adopted by the various stakeholders to develop a CE.
- The findings related to the attitudes and willingness to cooperate amongst current and future professionals working in this sphere of activity revealed encouraging and optimistic perspectives from (i.e., good intentions of) stakeholders to the CE development, despite benefits and costs not always being evident to all participants.

The main limitation is the relatively small (although significant) sample as it compromises the possibility to generalise the results, especially from the more generally CE-aware industrial community surveyed to companies not directly involved in the CE transition. The survey aimed to collect data from those in senior posts and highly aware CE and sustainability individuals, which would result in a modest number of high-quality responses. The study can be applied to other contexts (apart from solid waste management) and different cohorts of respondents in the CE transition. However, future applications of such a questionnaire survey should aim to address the wider, less well-informed communities, all of whom should have an interest in the movement towards a pervasive CE since it offers multiple benefits, both to stakeholder groups themselves and the necessary advancement of sustainability and resilience. In this respect, the survey should be married to an information and awareness campaign along with an articulation of the (e.g., UKCRIC) methods available to make beneficial change happen. Also, the use of more elaborate statistical techniques could help to improve the analysis and robustness of the results from the survey. It is recommended that future research should measure the willingness to cooperate from stakeholders by using other approaches (e.g., willingness to accept/pay methods) to achieve such a CE transition.

**Author Contributions:** Conceptualisation, P.G.P.-A.; methodology, P.G.P.-A.; analysis, P.G.P.-A.; writing—original draft preparation, P.G.P.-A.; writing—review, editing and linkages to parallel research, D.V.L.H. and C.D.F.R.; supervision, D.V.L.H. and C.D.F.R. All authors have contributed substantially to the work reported. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received the financial support of the UK EPSRC under grants EP/J017698/1 (Liveable Cities), EP/K012398/1 (iBUILD) and EP/R017727/1 (Coordination Node for UKCRIC). The first author would also like to thank his sponsor, CONACYT–SENER, for funding his doctoral studies at the University of Birmingham under scholarship 305047/441645.

**Institutional Review Board Statement:** Ethical review and approval was obtained from the University of Birmingham Ethical Committee (ERN\_19-0203A on 18 March 2021).

**Informed Consent Statement:** Written informed consent has been obtained from the participants to publish this paper.

**Data Availability Statement:** The data presented in this study are not publicly available due to privacy, confidentiality and ethical reasons.

**Acknowledgments:** The authors gratefully acknowledge the voluntary participation of the students from the Sustainable Construction module at the University of Birmingham, the students from the University of Oxford, and participants from the ARLI project. Special thanks go to Jon Roberts from ARLI for his help in refining and distributing the questionnaire.

**Conflicts of Interest:** The authors declare no conflict of interest.

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