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A Methodological Assessment Based on a Systematic Review of Circular Economy and Bioenergy Addressed by Education and Communication

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Abstract: The circular economy and bioenergy are essential strategies for combatting climate change. In the last 10 years, there has been an increase in research on this subject by different disciplines. Educational and communication approaches may prompt a change to make citizens agents of change in the environmental struggle. Therefore, evaluating their level of methodological formalisation allows the identification of characteristics of the research carried out, and to ascertain where academic studies in these disciplines are aimed. Through a systematic literature review (SLR) applying the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model, literature from 2009 to 2019 was identified on the Web of Science, Scopus and Google Scholar, using Publish or Perish software to obtain it. A qualitative and quantitative synthesis of the results was carried out, using cluster analysis and statistic percentages, and comparing column proportions. The analysis of the articles ($n = 74$) focused on collection techniques, data typology, characteristics of samples and analysis techniques, and showed that the majority were descriptive, oriented toward presenting proposals on educational intervention, with small samples and basic analytical techniques. Despite consistency in the corpus of the research, it is concluded that the studies had a low level of methodological formalisation, which indicates it they were generally related to exploratory research with limited scope, addressing a limited part of the object of study.

Keywords: systematic literature review; meta-analysis; communication; education; sustainability; bioenergy; circular economy; methodology; research methods

1. Introduction

In recent years, climate change caused by human activity has become a real threat for all species which live on this planet. The increase of the earth's temperature, floods and melting ice are some of the visible consequences of this issue [1–4]. The foreseeable growth of the population at a global level [5] entails a challenge for businesses and institutions when producing and supplying both resources and services sustainably, posing the need to develop universal measures focused on long-term development of the planet. Additionally, it is estimated that consumption of resources and materials at a global level will double by 2060, considerably increasing the amount of waste produced by human beings [6]. All of these changes will entail a challenge for businesses and organisations in the future. Increased consumption of energy, goods and services will require implementing sustainable strategies and seeking efficient technologies which address the implementation of regenerative models to minimise environmental impact.

The circular economy (CE) and bioenergy are two novel solutions for combatting climate change and reducing environmental impact based on the simplification of production processes and the use of renewable energy [7]. Both measures are positioned as complementary solutions for achieving effective and sustainable production and consumption models. CE involves reformulating production processes and making an effective transition from a

linear model to a circular model [8]. To do so, it is necessary for businesses, institutions, governments and academia to work in cooperation [9]. The European Union is aware of the growing benefit of the circular economy. Consequently, to make real use of resources, measures are being developed to accelerate the transition to this regenerative model based on circularity of production processes [10].

Bioenergy is a source of energy which allows natural resources to be exploited to convert them into renewable energy. It is one of the most widely used globally [11] and its use directly contributes to a sustainable economy model [12]. Thus, it promotes the recycling of waste to give it new life. However, despite its potential, its execution entails a challenge for businesses due to the lack of qualified personnel and the high cost of implementation of the technology necessary for its development and production. Additionally, awareness and the development of proper judgement, and the development of critical attitudes among citizens, are of great importance, to make citizens aware of the value they contribute to their everyday lives [13–15].

Both areas have attracted the interest of numerous research studies in recent years [16], with diverse disciplinary approaches including engineering [17], design and fashion [18], psychology [19], economics [20], education [21] and communication [22]. Despite its multidisciplinary character, the implementation and use of this technology is commonly associated with technical areas such as engineering, experimental sciences and technology. However, social sciences must not be overlooked because through these, the social and cultural implications of this innovative technology on society can be ascertained [23]. In fact, implementing and promoting the correct habits among the population regarding sustainable innovations may directly contribute to the creation of ecological awareness, as well as creation of new jobs.

To make an effective transition in the production model, a change of citizens' mentality is necessary. Critical thought favours the creation of responsible habits among citizens. School and the media are two key elements to achieving real commitment to the environment from citizens. Thus, numerous research studies assert the need to raise the awareness of future generations on both the circular economy and bioenergy, through educational actions and awareness campaigns [24–27].

In the educational field, research has been carried out focused on ascertaining the level of implementation of materials related with to CE and bioenergy at a curricular level in formal education [28]. Research focused on the creation of educational models for working on these issues in schools and universities has been undertaken [1]. In addition, research in measuring the level of awareness and perception of studies has been carried out [15,29]. At an international level, the United Nations Educational, Scientific and Cultural Organization (UNESCO) [30] endorses the need to work from an educational approach to train future generations and contribute to sustainable development which respects the environment. Additionally, among the sustainable development goals (SDG), the United Nations (UN) recognises the need for citizens to acquire the necessary skills to promote interest and awareness in these issues, which are so important for the continuity of ecosystems and life on earth [31]. To achieve a generalised democratisation of knowledge, these areas must be worked on with a focus on diversity, including different inherent economic, social and ethical views [32].

Furthermore, in the field of communication, studies focused on measuring and analysing awareness and change of attitude based on studying the media, are notable. An example is found in the research by Skjølsvold [33], focused on measuring interest in the Nordic media disseminating journalistic articles which allow awareness and communication of information on renewable energy. Notable also are studies focused on measuring persuasive communication actions, through the use of audiovisual media, to ascertain the perception of consumers [34].

These fields are of great importance for making citizens, especially young people, into true agents of change, fighting to achieve a sustainable future. Additionally, they are of great interest as objects of formal and material study of numerous research works, being an

emerging area with an interdisciplinary and multidisciplinary nature, which has become prominent in recent years [35]. This, in addition to the considerable increase of scientific publications [36], promotes investigation of their characteristics and how these fields are addressed from an academic perspective.

Scientific knowledge is characterised by its rigorous, progressive and accumulative nature. The progression of knowledge is essential not only for the advancement of science, but also for the improvement of society [37]. In the academic world, the approach and design of a study are essential for establishing both the starting point and the potential conclusion of research. To begin, it is of great importance to ascertain the features of the formal object of study that the researcher is approaching. Bibliographic reviews allow exploration of the different views that make up a field of study based on the retrospective observation of the literature existing on the issue. As a result, the key points of similar research can be ascertained synthetically, obtaining as evidence the topics, techniques, methods, theories and notable results of a field of knowledge [38]. Thus, critical analysis of the literature allows up to date knowledge of both existing lines of research and emerging theories of a specific discipline. However, despite being a rather widespread method, the type of bibliographic review to be carried out should be specified to follow a methodical and structured process [39].

Specifically, among the literature review processes notable for following a rigorous, ordered and analytical process is the systematic literature review (SLR). This method is distinguished because, in addition to allowing the characteristics of publications to be known in a certain time and research field [40], it obeys exhaustive protocols which guarantee its replicability and reproducibility. This technique facilitates the recovery of scientific literature from different databases such as Web of Science and Scopus and may be accompanied by qualitative and/or quantitative analyses such as text-mining, systematic mapping, clustering and content analysis. Being a relatively new area of study, academia is undertaking systematic literature reviews to ascertain the perspectives and focuses of these research works, although the studies carried out focus on finding the qualitative characteristics of the publications in specific areas, such as green innovation [41], corporate social responsibility (CSR) [42] and sustainability of manufacturing industries [43]. As a result, research works focused on specific issues directly related with sustainable development are found.

The lack of studies focused on identifying and evaluating the formal characteristics of research in a generalised way entails an opportunity for analysing scientific publications focused on the circular economy and bioenergy carried out from communication and education. Finding precisely how they are carried out, and where the academic studies are aimed, allows future research to be carried out, promoting sustainable development of the planet through the circular economy and bioenergy. The current research carries out a systematic literature review (SLR) of the academic articles published between 2009 and 2019 on these issues, accompanied by a qualitative and quantitative synthesis of the results. The main objective is to evaluate the level of maturity of this area of research, considering the level of methodological formalisation of the published research based on the examination of information collection techniques used and the data offered, the characteristics of the samples used, and the analysis techniques applied.

To achieve the objective of the research, the following specific objectives are proposed:

- SO1. Describe the predominant information collection techniques.
- SO2. Identify the typology of the data collected.
- SO3. Determine the characteristics of the samples used.
- SO4. Determine the analysis techniques used.

In Section 2 of the article, the methodological procedure of the study is detailed, describing both phases of the systematic literature review (SLR) and the qualitative and quantitative synthesis carried out in the analytical process of the study. The results and analysis are presented in Section 3, following the described methodological structure of the research. The conclusions are detailed in Section 4.

2. Materials and Methods

To evaluate the level of maturity of the research area, both quantitative and qualitative techniques were used. The study was carried out in two phases. First, the systematic literature review (SLR) technique was used to gather and examine the publications of the areas of study. Second, after the selection of the articles, a content analysis was carried out following a clustering process focused on the methodological body of each one of the articles. With this process, in addition to identifying the relevant publications of the areas of study, their formal characteristics were identified. Below in Figure 1, a diagram of the procedure carried out is shown, using the methodological structure of Fernández-González et al. [44] as a reference:

Figure 1. Phases of the study.

2.1. Planning of the Research

In systematic literature reviews, planning is of great importance for guiding searches and selecting the sample of publications to be analysed on the object of study. As previously explained, the objective is to ascertain the level of formalisation of the area studied through the analysis of the methodological level presented by the corpus of the scientific literature published. Specifically, the study focuses on information collection techniques, the data collected, the characteristics of samples and the analysis techniques used. In Table 1 objectives and research questions oriented toward analysis of the publications are therefore posed:

Table 1. Relationship between specific objectives and research questions.

Specific Objectives	Research Questions
SO1	RQ1.1. Is there a dominant information collection technique? RQ1.2. Does the information collection type determine one or another sample size? RQ1.3. In what disciplines is more than one information collection technique used? RQ1.4. In what type of research are more research techniques used? RQ1.5. Is there a relationship between collection techniques and the research discipline, type and objectives? RQ1.6. Is there a relationship between the type of information collection technique and the source of data obtained?
SO2	RQ2.1. What is the predominant source, nature and type of data collection? RQ2.2. Is there a relationship between the nature of data and the research type and objective? RQ2.3. Is there a relationship between the source of data and the research discipline, type and objective?

Table 1. Cont.

Specific Objectives	Research Questions
SO3	RQ3.1. What type of research declares the study universe? RQ3.2. What is the predominant sampling technique? RQ3.3. Is there a relationship between the sampling techniques and the source of data, nature, and data collection of the study? RQ3.4. Is there any relationship between the area of study and the sampling techniques? RQ3.5. Have the largest samples under the sampling techniques been selected?
SO4	RQ4.1. What are the predominant analysis techniques? RQ4.2. Is there an association between analysis technique (primary and secondary) and research discipline, type and objectives? RQ4.3. Is there consistency between the type of analysis techniques used and the source of data, nature and collection of data?

2.2. Phase I: Systematic Literature Review

The systematic literature review (SLR) evaluated the publications focused on the circular economy and bioenergy in the areas of education and communication. The process was adapted to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol to guarantee replicability and reproducibility of the study in future research [45,46].

Not only does the PRISMA statement allow a guideline for accurate and consistent results, but also for excluding literature that is not relevant when carrying out a systematic review.

In the results section, the findings corresponding to each phase of the process are shown.

2.2.1. Identification of Publications

Selection criteria for the scientific literature were established, determining the search terms, databases and time period for gathering the publications. Working in two areas of knowledge on a common topic, three vocabularies were established for undertaking the searches. The terms were selected in English.

First, vocabulary common to both areas related with sustainability was established. The selection of terms related with the circular economy and bioenergy was carried out by experts in circular bioeconomy in the setting of the Circular bioeconomy in the urban environment (BIOTRES-CM, S2018/EMT-433) project. This project is financed by the Community of Madrid and the European Regional Development Fund and has the objective of transforming biowaste in the urban environment to improve the quality of life of people of the Community of Madrid in Spain. Six terms were selected.

To identify the specific words in the fields of both communication and education, a process was undertaken using automated extraction of keywords from publications from the last 10 years indexed in the Scimago Journal & Country Rank and in the journal Citation Reports [47]. Twenty-five words were selected for the field of communication, and 20 for the field of education.

Once the keywords were determined, Boolean operators were created with logical connectors to guide the searches. For their construction, each one of the keywords related with circular economy and bioenergy was combined with each one of the words established in each field. As a result, the following search equation was used, in which the words were combined with the AND and OR logical operators to construct each one of the Boolean operators:

$$\text{"General word"} \text{ AND } (\text{"Specific word 1"} \text{ OR } \text{"Specific word 2"} \text{ OR } \text{"Specific word 3"} [\dots]). \quad (1)$$

2.2.2. Search Procedure

To gather the publications, the Publish or Perish [48] program was used, applying a time margin of 10 years (2009 to 2019) to gather the scientific literature. Scopus, Web of Science and Google Scholar were selected as the most relevant sources for focusing searches and gathering the scientific output with greatest impact. The searches were carried out at

two different times with constructed Boolean operators. In principle, only the publications working on the circular economy and communication were to be gathered. However, after analysing the first results, it was decided to repeat the process including terms related with education, due to the close relationship between both areas of study. The first search was carried out in July 2019 and the second in April 2020 from the network of the Rey Juan Carlos University. The searches were carried out in the title section.

The publications gathered from the communication field covered the period from January 2009 to April 2019, although the metrics of the publications gathered were updated in April 2020 to make the data up to date. The publications of the education field covered the whole period from 2009 to 2019. To facilitate the filtering procedure, all results were unified and exported in CSV format to be able to proceed with the next phase of the process. As a result of the search procedure, six matrices of results were found associated with the search and database consulted.

Among the fields recorded in the results matrix were values related with the bibliographic data of the articles and their impact metrics. First, the following bibliographic data was found: title, authors, year, source, Publisher, article URL, type, DOI, ISSN, Volume, Issue, StartPage, EndPage. Second, the impact metrics were found: cites, cites URL, GSRank, ECC, CitesPerYear, CitesPerAuthor, AuthorCount, Age.

2.2.3. Refinement and Filtering

In the resulting matrix, the data obtained from the extraction by database were included, with only the fields used in the analysis remaining. Thus, the bibliographic fields common to the three databases were unified (Authors, Source, Publisher, DOI and Age). Once the matrix was obtained, the publications were ordered by ascending chronological order. After unifying and ordering all results in a single matrix, the initial criteria of selection and exclusion of articles were determined. Firstly, duplicate publications were eliminated, with only the unique values remaining. After this process, the matrix was exhaustively reviewed manually to check that there was no value repeated due to typographical error. As a main criterion, for the exclusion of publications, it was decided to maintain the papers, proceedings papers and conference papers, in English. The impact metrics remained separate based on the database of origin so as not to use the original reference. Additionally, to facilitate the reading of the matrix in the analysis process, colours were assigned to each one of the cells based on the database of origin: green for Web of Science, orange for Scopus and blue for Google Scholar. Fields were also included for “no data” to indicate that this field was not available, and for “no index” in grey, to indicate that this publication was not indexed in this database.

Next, the abstracts of the selected publications were evaluated to check their relationship with the research topic. The evaluation was carried out by two researchers who are experts in the areas of study.

Finally, after evaluating the eligibility of the publications, the articles were gathered for subsequent analysis in full. In this final phase, articles which could not be accessed, and which were not directly related with the research topic, were excluded.

2.3. Phase 2: Qualitative and Quantitative Synthesis

2.3.1. Study of the Publications

Once the sample was established ($n = 74$), the publications were studied. To do so, a qualitative process of clustering of articles was carried out to organise and establish categories related with the object of study of the research. After exhaustive reading of the publications, the results were recorded in a table of variables following the Descriptor for a systematic literature review on social sciences (DESLOCIS) model [49]. Although this model evaluates the publications in full, this study focuses on the variables oriented toward the analysis of the methodological body of the articles directly linked with the research questions established in the planning of the study. After the clustering process,

the results were codified following the book of codes of the DESLOCIS model to develop the quantitative analysis of the selected variables.

2.3.2. Quantitative and Qualitative Analysis

The analytical procedure of the study was carried out both qualitatively and quantitatively. The results of the qualitative synthesis were obtained from the analysis of the textual corpus of the articles.

The codified values were distributed by frequency tables and the results were obtained through a univariable or multivariable statistical study based on the research question to be answered. Thus, the univariable study was carried out through analysis by frequencies and vertical percentages. The multivariable study was carried out through the table of checks of proportions by column using the Z test to determine whether there was a significant difference between the compared percentages. The analysis was carried out with SPSS software. Additionally, for the representation of the data, stacked bar graphs were used, indicating the significant values in red.

3. Results and Analysis

3.1. Phase I: Systematic Literature Review (SLR)

In Figure 2, the result of the flow diagram of the systematic literature review is shown, following the PRISMA model.

Figure 2. PRISMA Statement flow diagram.

Below, the results are elaborated upon in detail, following the methodological process described in the previous section.

3.1.1. Identification of the Publications

As indicated, the selection of terms is of great importance for orienting the results. In Table 2, the combination of general words and specific terms of the area of communication is shown:

Table 2. General and specific keywords—communication.

General Vocabulary	Specific Words: Communication				
Urban biowaste	Advertising	Marketing	Persuasion	UX	Usability
Circular economy	Communication	Effectiveness	Memory	User experience	Digital content
Chemical biobased products	Communications	Engagement	Credibility	Experience	Cross media
Bioenergy	Media	Education	Attention	Eye-tracking	Transmedia
-	Digital	Higher education	Motivation	Eye tracking	360° video

In Appendix A, the Boolean operators constructed with the combination of terms of Table 2 and the logical operators AND and OR are shown. Table 3 shows the combination of keywords for constructing the Boolean operators, which form the search of the education field:

Table 3. General and specific keywords—education.

General Vocabulary	Specific Words: Education			
Urban biowaste	Children	Distance-learning	Learning	Social Network
Circular economy	Education	E-learning	Research	Student
Chemical biobased products	Communication	Information technology	School	College students
Bioenergy	Media Literacy	Information Communication technology	Media	Communication education
-	Disinformation	Internet	Social Media	Learning experiment

In Appendix B, the Boolean operators constructed with the combination of words of Table 3 and the logical operators AND and OR are shown.

Once the search equations were established, the publications were gathered using the Publish or Perish program. Table 4 shows the results in each one of the databases of the searches carried out:

Table 4. Total number of publications gathered in each one of the databases.

Database	CE and Communication Publications	CE and Education Publications Added	Totals
Web of Science	61	48	109
Scopus	96	83	179
Google Scholar	164	99	263
Totals	321	230	551

The gross data is available in the first Zenodo document [50]. The document includes all records separated by database, amounting to a total of 551 publications.

3.1.2. Refinement and Filtering

Having obtained the publications, the results were obtained in a single matrix. Next, duplicated values were eliminated, resulting in a total of 262 unique publications. After the manual review, three publications that were repeated were eliminated. As a result, 259 unique values were consolidated. The data from the publications is available in the second Zenodo document [50].

After applying the selection and exclusion criteria, and reviewing the abstracts of the publications, the matrix was updated, offering a result of 170 articles.

These articles were studied in-depth by researchers, and it was decided to exclude 96 publications due to not matching the research objectives, or due to them being impossible to recover. The data from this part of the procedure can be found in the third Zenodo document [50].

As a result of the whole procedure, the final matrix was obtained, made up of the 74 articles that were included in the subsequent analysis. The results can be found in the fourth Zenodo document [50].

3.2. Phase II: Qualitative and Quantitative Synthesis

3.2.1. Study of the Publications

Once the study had been carried out and the article clustering process completed, the following table of results was obtained [51]. As a result of the codification process, the following table of codes was created with the variables used in the statistical study [51]. In the following sections, the results of the study are presented and analysed following the specific objectives and research questions posed. The statistical study is available in the following document [51].

3.2.2. SO1. Describe the Predominant Information Collection Techniques

RQ1.1. Is There a Dominant Information Collection Technique?

As an information collection technique (primary and secondary), the research used documentary techniques (40.5%), surveys (28.4%), observational techniques (20.3%), conversational techniques (13.5%) and experimental techniques (2.7%). In Figure 3 the distribution of the information collection techniques of the research is shown.

Figure 3. Information gathering techniques.

In the collection of information from the articles, the documentary technique was predominant, specifically for content analysis. These publications were mostly focused on undertaking reviews of literature with topics of circular economy focused on the academic-scientific field [17,52–55], and some of them in the education field, aimed at the application of active methodologies [8,56–58]. There were also publications which undertook discursive analyses of articles from both newspapers [33] and from scientific publications which work on Open Online Education and Moocs in the field of education for sustainability [21]. Notable were publications which undertook documentary analysis focused on the bibliometric study of publications which applied Big Data and Internet of Things within the CE [59], and Life Cycle Analysis to evaluate environmental performance [60]. Second, there was research which used surveys as information collection methods. Thus, within their typology, those which focused on opinion were notable compared to those which gathered attitudes. As a main result, opinions were obtained from students who participated in edu-

cational interventions. These proposals were focused on active methodologies such as role playing and gamification in CE [5], service learning and action learning applied in water treatment [61] and energy plants [62], and the development of proper judgement in chemical education [14]. Additionally, opinion surveys were formulated in the business field to ascertain the role of experts, agents and stakeholders in the field of Small and medium-sized enterprises (SMEs) in Europe and their activities [63,64]. There were also those aimed at businesses oriented toward the production of zero waste [20], the communication of waste footprint [65], implementation of bioenergy [66] and the transformation of business models through digitisation based on CE [67]. Attitude surveys mostly focused on changing the behaviour of students, addressed by the Theory of Planned Behaviour and psychology, the intention of using renewable energies [19], the acquisition of environmentally favourable behaviours [15] and the possibilities of application of bioenergy [68].

The observational techniques were generally notable for detailing and describing educational interventions gathered by the researcher, with proposals focused on the areas of design [69] and ecodesign [25], chemistry [70] and Science, Technology, Engineering and Mathematics (STEM) areas [1], and in web environments integrated with machine learning to publicise biorefineries [71]. There was also research which applied observational techniques to create theoretical frameworks for future production systems in engineering [72], design and European firms [73] and in CE in education [74]. Finally, there were studies which applied this information gathering technique from the area of communication to involve the audience through scientific posters [75], SWOT models and environmental communication of businesses [76], the promotion of responsibility in sustainable fashion brands [77] and the design of product production stages for the reduction of environmental impact [78].

Conversational gathering techniques are notable for moving toward the educational and business sectors. Thus, in the school environment, both focus groups and interviews were held with experts and stakeholders to understand the level of implementation of CE in educational institutions, both at a curricular level in higher education [79] at college level [80] and at a structural level [18,79]. In the business sector, information was gathered from agents and policy makers for technological development in bioenergy [81], the implementation of business models and sustainable manufacturing [82] and ultimately, the search for differentiation on the market based on an ecoinnovative framework based on CE [80].

In turn, the majority of information gathering used a single technique (93.2%) compared with research that used two or more (6.8%). Notable among the primary techniques used were documentary techniques (39.2%), through content analysis (32.4%), discourse analysis, (2.7%) documentary analysis (2.7%) and others (1.4%). Next were surveys (27%) using attitude surveys (6.8%), opinion surveys (16.2%) and others (4.1%). Used also were observational techniques (20.3%), using self-observation (17.6%), systematic observation (1.4%) and participant observation (1.4%). Fourth were conversational techniques (10.8%), using Delphi (2.7%), open interviews (1.4%), semistructured interviews (2.7%), focus groups (2.7%) and discussions on social networks (1.4%). Finally, in the minority, was research that used experimental collection techniques (2.7%) through undertaking field experiments (1.4%) and group experiments (1.4%).

The studies that used secondary information gathering techniques were a minority and used conversational methods (4.1%) either through open interviews (1.4%), semistructured interviews (1.4%) or focus groups (1.4%). This research was characterised by using more than one information gathering technique. Although none of these used observational techniques, they are notable for focusing on the education sector, specifically on the area of higher education for developing learning programmes and courses on the topic of CE [83,84] and the implementation of strategies based on CE in the academic environment [85]. There was also research focused on understanding [86] and the provision of innovative solutions [87] for SMEs when applying CE in their business models.

RQ1.2. Does the Information Collection Type Determine One or Another Sample Size?

Samples of 1 to 50 (27%) participated in research collected by surveys mainly made up of students from different educational levels: basic school level [88], high school [14], undergraduate [62] and postgraduate [61]. There were also samples made up of active professionals [34,65,83], representatives [52] and experts [13,66]. Notable within this interval were samples collected through conversational techniques. These samples were made up of a broadly professional profile referring to policy makers [82], stakeholders [85], agents of educational institutions [18] and experts [89] and academic scientists and representatives of the economic and industrial sector [81]. Finally, the documentary techniques which used samples from 1 to 50 were made up of scientific literature and publications [21,87], websites [90] and academic work [84].

The information collection techniques in research with samples of 51 to 100 (5.4%) were guided by surveys of students [5] and representatives of small businesses [86], and conversations with experts [80] and agents of the educational sector [79].

The collection techniques with samples of 101 to 200 (4.1%) were fully made up of surveys aimed at students in primary school [68], high school [15] and at university [91].

There were various collection techniques with samples from 201 to 500 (5.4%). First, there were documentary techniques, review of courses and PhDs on biomass, bioenergy and biofuel [28], and official documents [92]. Second, and to the same degree, there were collection techniques by survey and conversations aimed at students [29] and subjects who participated in discourse on social networks [59].

The survey was the only collection technique in samples between 501 and 1000 participants (1.4%), collecting data from high school students [19]. In samples between 1001 and 2000 (1.4%), only documentary information collection techniques were used; specifically, newspapers as a communication media, publishing content on bioenergy [33].

The majority of samples with over 2000 participants (14.9%) used documentary collection techniques. Thus, information was collected from scientific literature on CE and Internet of Things (IoT) [59], life cycle analysis for bioenergy [60] and green marketing and industry [93–95]. The surveys which used these samples focussed on the business sector, aimed at collecting data from European SMEs [63,64]. Finally, there were observational techniques which collected information from SMEs and European firms [73] and educational courses on product development [96].

It is important to indicate that 40.5% of research did not use samples.

Below is the relationship between the information collection techniques and the sizes of the samples of the research. For the set of checks associated with information collection techniques by conversations, it was observed that samples of 1 to 50 were significant with regard to research which used samples of over 2000. It must be noted that samples of 51 to 100 were high, but not significant as there were few records. For checks associated with documentary collection techniques, it was found that samples of over 2000 were significant in comparison with the rest of the sample sizes. In the checks associated with collection techniques by surveys, samples of 1 to 50 were more significant than those of over 2000. It is notable that surveys were used in all samples except for those of 1001 to 2000. For experiments, there were no keys in any column; this type of technique does not usually involve collecting information by the characteristics of the research. Finally, for the checks associated with observational collection techniques, it was observed that samples of over 2000 were significant with regard to the rest of the sample sizes in which there was no representation.

RQ1.3. In What Disciplines Is More Than One Information Collection Technique Used?

Research that used more than one information collection technique were a minority, although in all areas (except for health sciences) there was at least one research study that used more than one information collection technique.

In social sciences there was research which carried out case studies combining surveys with documentary and conversational methods to collect information. These techniques

focused on the exploration of constructs in the field of business ecosystems [87] and theoretical examination in CE in the economic-business field [86].

In the disciplines of art and humanities, the use of case studies with documentary and conversational methods for collecting information is notable. These techniques were used for examination of how to apply circular frameworks in the real world [84] linked with the educational and artistic field.

The discipline of science includes techniques which used surveys and documents [83] to develop a strategic model that uses CE in Higher Education Institutions to improve energy management and reduce environmental impact.

Finally, in engineering and architecture [85], conversational techniques were used at different times to analyse and establish practices related with CE in higher education.

In Figure 4, the relationship is shown between the number of information collection techniques and the disciplines to which the study belongs. For the checks associated with research that used two or more research techniques, keys are not included in any of the columns. As can be seen, there were not significant differences in the proportions of disciplines that used more than one information collection technique.

Figure 4. Comparison between the research discipline and the information collection techniques.

RQ1.4. In What Type of Research Are More Research Techniques Used?

The only type of research that used more than one information collection technique was analytical research. This research focused on analysis to establish business models in businesses for implementation and promotion of the transition toward CE [84,89]. There was also research which examined products to guarantee that they fulfilled the criteria of circularity [84]. Notable also was research which analysed the barriers to transition toward CE [86] and which focused their interest on developing methodological frameworks to improve strategies for sustainability of educational institutions [83]. Descriptive, comparative and participative research used a single information collection technique.

In Figure 5, the relationship is shown between the type of research and the collection techniques. For checks associated with research that uses one information technique, the proportion of descriptive, comparative and participative research was greater than the proportion of analytical research. In checks associated with research that uses two or more information collection techniques, it was observed that the proportion of analytical research was significantly greater than that of descriptive, comparative and participative studies that used two or more information collection techniques.

Figure 5. Comparison between the research type and number of information collection techniques.

RQ1.5. Is There a Relationship between Collection Techniques and the Research Discipline, Type and Objectives?

Research that uses conversational collection techniques was found in the disciplines of engineering and architecture, arts and humanities, and social and legal sciences. The research found in the area of engineering and architecture focused on the application of sustainable solutions and models to buildings and higher education institutions [79,85] and presentation of the feelings that the media generated in the field of bioenergy [22]. Contextualised research in the discipline of social and legal sciences were addressed from the business perspective to establish the key elements of the circular economy in production processes, considering policy makers [82], experts [81] and small and medium sized businesses [89]. Arts and humanities work to examine art institutions which seek to establish CE solutions [18] and their curricular implementation [80].

Research that used documentary information collection techniques was found in all disciplines. The area of engineering and architecture mostly focused on the planning of educational models [97] for higher education to teach about bioenergy [28], water energy [98], biorefineries and biomass [99]. In social and legal sciences, there was research that worked by proposing bibliometric models in Big Data and Internet of Things related with CE [59] and Life Cycle Assessment (LCA) [60]. Literature reviews were also carried out focused on media dissemination to raise awareness on the issue of bioenergy and renewable energy [33], as well as exploring the applicability of marketing strategies in biofuels [93] and CE [90]. In arts and humanities, the research works on the implementation of CE [56,84] and sustainable development goals [21] in the educational field, addressed some cases from the field of design based on collaborative models [100]. In the discipline of science, there was research which presented the relationship between CE and IoT [101] and their applicability in the city through sustainable agriculture programmes [102]. In health sciences, the only contextualised research in this discipline worked on the association between CE and IOT in the fields of medicine and bioinformatics [55].

Research that used information collection techniques by surveys was found in practically all disciplines. In engineering and architecture, the research focused on the application and evaluation of active educational methodologies in STEM areas [61,91] such as the application of gaming [5] and the development of activities through project-based learning [62]. There was also research which promoted the proper judgement [14] of students in chemistry, and the development of appropriate communication actions in Life Cycle Assessment [65]. In social and legal sciences, the research worked to explain and measure

both perception [15] and intention of using [19,68] bioenergy by students. Notable also was research that attempted to implement strategies based on CE in business models in small and medium sized businesses [64,86] through ecoinnovation [63] and marketing [67]. In science, the studies proposed to measure both students' knowledge of bioenergy [29] and the attitude of consumers for the development of strategies based on CE [34]. They also analysed the participation of stakeholders in projects related with bioenergy [66] and developed methodological proposals for the management of sustainable processes in educational institutions [83]. In arts and humanities, research focused on measuring perception, knowledge and teaching attitude to achieve a model of Education for Sustainable Development [13], and on studying the perception of students [88].

Research that used information collection techniques through experiments was found in engineering, architecture and science. In engineering and architecture, analytical models were used to involve universities in the production of a dairy facility through social and environmental responsibility [24]. In science, there was a focus on incorporating green chemistry in the educational field based on laboratory work [103].

Finally, studies which used information collection techniques through observation were found in practically all areas. In engineering and architecture, research was carried out seeking to understand how to properly apply environmental communication tools to ensure recycling of waste [76], and descriptive educational interventions [27,104] which work by integrating aspects of CE in the field of sustainable production [96]. Additionally, there were proposals related with bioenergy in engineering curriculums [70] to increase the awareness of CE students [72]. Finally, in this discipline there were studies which integrated solutions based on CE in building [74]. In social and legal sciences, the focus was on the study and analysis of application of CE in European firms [73], while in science there were studies that worked on evaluating the engagement of communication products with issues focused on sustainable bioenergy [75] and proposals for evaluating educational models in STEM areas in the field of renewable energy [1]. In art and humanities, it was sought to create awareness in consumption habits in the fashion industry [77] and the design of both university courses on CE [25] and collaborative projects in the context of strategies for Educational for Sustainable Development (ESD) for students who work on product design [69].

In Figure 6 the relationship is shown between information collection techniques and the discipline in which the study was contextualised. For checks associated with research encompassed in the discipline of engineering and architecture, it is observed that there were no keys or significant values for any of the collection techniques, although all were included to a greater or lesser extent. The checks associated with research encompassed by social and legal sciences showed that the proportion of conversational, documentary and survey techniques had greater values than observational and experimental collection techniques. Thus, the significant techniques of information collection by surveys were greater than conversational techniques, which were in turn greater than documentary techniques. For the set of checks in art and humanities, there were not significant values. Collection techniques were found in all records except for experimental, as the sample was small. For checks associated with science, the proportion per survey was greater than the rest of the collection techniques. In health sciences, there were no keys.

In Figure 7 the relationship is presented between the collection techniques and the type of research. For checks associated with descriptive research, it is shown that the proportion of observational techniques had significant values compared with documentary techniques. Both, in turn, were proportionally greater than the rest of the information collection techniques. In the checks associated with analytical research, it is observed that the proportions of research which used conversational techniques and surveys showed significant values and were greater than documentary and experimental techniques. The checks associated with comparative techniques indicated that the surveys were significant and used more than the rest of the information collection techniques. Participative research did not present keys or significant values in any of the records.

Figure 6. Relationship between collection techniques and research discipline.

Figure 7. Relationship between information collection techniques and the type of research.

Finally, presenting the collection techniques and research objectives, no significant results were found. The checks associated with objectives that analysed, detailed and deconstructed, and which used conversational techniques, were greater than those which used surveys. In turn, the checks associated with objectives which described, detailed and defined, which used documentary techniques, were greater than those which used surveys.

RQ1.6. Is There a Relationship between the Type of Information Collection Technique and the Source of Data Obtained?

The majority of research worked with primary data. The studies which used nonnumerical primary data collected information by conversational techniques from stakeholders from the educational field [18,79,85], from experts on bioenergy [81] and researchers on sustainability in the business field [89]. There was also collection by observation of data from educational proposals working on green chemistry [70], STEM [1] design and CE [25,69,96] and with methodologies that promoted situated learning and service [77,104]. Collected through this technique, were also construction processes of a biorefinery, procedures for sustainability in the field of fashion [77] and information on communication products based on CE [75]. Finally, surveys were used, aimed at engineering students [5,61] and consumers from small businesses [20].

The studies which used numerical primary data gathered information from surveys of teachers [13] and students at primary school [29,88], high school [14,15,19,68] and at university [62,91]. This data was also collected from surveys carried out on experts in bioenergy [66] and CE [65], and stakeholders and representatives of companies [64,67]. Additionally, numerical primary data was collected from conversations with policy makers of companies [85] and experts from the educational field [80]. In the same way, data was collected through observation on a web platform based on machine learning for industrial management [71]. Finally, experiments were collected on systems of biogas [24] and sustainable chemicals and fuels [103].

Studies which worked with numerical secondary data were notable for using documentary techniques. This research gathered information from scientific literature on issues such as CE in industry and business [105], the educational field from environmental education [56,57], education for sustainable development [8,21] and accounting education [52]. Data was also collected from documents which worked with CE, big data and IoT [59,101]. Studies which worked with numerical secondary data were a minority, although they collected information through surveys [63], observations [73] and documents [92].

In Figure 8 the relationship is shown between information collection techniques and the source of data obtained. For the set of checks associated with research which used non-numerical primary data, it is shown that research that used conversational and observational techniques were significant compared with documentary, survey and experimental techniques. In checks associated with studies that use non-numerical secondary data it is observed that the documentary techniques were significant compared with other research that used conversational, survey, experimental or observational techniques. Checks associated with numerical primary data showed that surveys were significant and greater than conversational, documentary and observational techniques. Finally, the set of checks of research that used numerical secondary data did not have keys, being a minority in all records.

Figure 8. Relationship between information collection techniques and source of the data obtained.

3.2.3. SO2. Identify the Typology of the Data Collected

RQ2.1 What Are the Predominant Source, Nature and Type of Data Collection?

Research that used non-numerical primary data (41.9%) and secondary data (40.5%) was a majority. Below, the research which used numerical primary data (27%) and numerical secondary data (8.1%) are shown.

Analysing the nature of the data of the studied research, that which used categorical qualitative data was predominant (78.4%), followed by discrete quantitative data (29.7%), continuous quantitative data (12.2%) and binary qualitative data (6.8%).

The results showed that 63.5% of research obtained data from observation, followed by declarations with 37.8%. Finally, in the minority was research, which obtained data experimentally (2.7%).

RQ2.2. Is There a Relationship between the Nature of Data and the Research Type and Objective?

Research that used discrete quantitative data were analytical, descriptive, comparative and participative studies. In turn, analytical studies contextualised in the discipline of social and legal sciences work on concepts of CE in the field of the business and policy makers [64,73,82] and measured the intention of using bioenergy among students [15,68]. In the discipline of science, the issue of bioenergy was worked on both in the school environment [29] and in pilot projects [66]. In arts and humanities, the perception, awareness and attitude of teachers on bioenergy was measured [13]. Finally, in engineering and architecture, educational models related with bioenergy were developed [14]. Comparative studies were essentially found in social and legal sciences and in engineering and architecture for the adaptation of business models based on CE [67] and explained the intention of using bioenergy by students [19]. Descriptive research, found in engineering and architecture, worked on the efficient and responsible management of waste [76] and the use of web systems to execute processes in biorefineries [71]. Participative research was focused on the responsible management of universities from engineering and architecture [24].

Studies which used continuous quantitative data were mainly analytical research, although there were descriptive, comparative and participative studies. Analytical research worked on from social and legal sciences studied the transition of businesses toward CE models [63,86] and the level of influence of education on recycling rates of the population [92]. In science, work was carried out on green and sustainable chemistry in education [103]. In engineering and architecture, it was sought how to promote environmental skills among students [91]. Comparative research encompassed by art and humanities focused on students' awareness of bioenergy [88]. Descriptive research was situated in the discipline of engineering and architecture to work with sustainable products [97] and understand the role of citizens in the management of waste [76]. Finally, participative research was situated in engineering and architecture and focused on complex adaptive systems which were transitioning toward circular business models [87].

Research which worked with binary qualitative data was a minority and characterised by analytical studies. Thus, work was carried out from social and legal sciences in the field of implementation of strategies based on CE of the business [82,89]. Work was carried out in art and humanities to explore bioenergy in the educational field [13]. There was also studies in science, engineering and architecture which sought to propose sustainable solutions based on CE in education centres in both programmes and infrastructures [79,83].

Finally, studies which worked with categorical qualitative data were notable, being the most numerous studies in analytical and descriptive research. Thus, among all studies, analytical studies worked on from social and legal sciences were focused on proposing sustainable business models and communication strategies [20,90]. Work was also carried out on the application of concepts such as the Life Cycle Assessment in bioenergy [60] and Renewable Energy Technology (RET) in combination with IoT and Big Data [59]. In art and humanities, they were directly related with SDGs and learning processes [21] based on Cradle to Cradle and CE [84]. In engineering and architecture, studies were focused on issues related with bioenergy in the media [22] and on teaching students about the benefits of CE [5].

Descriptive studies were addressed from all disciplines.

In engineering and architecture, there were descriptive studies with a theoretical perspective which worked on CE [8] and its relationship with IoT and Information and Communications Technologies (ICTs) [17,53]. There was also a large set of research which described educational models related with sustainable issues. Thus, models were proposed for working with CE [57,72], proposals for green marketing in the industrial sector [94,95] and virtual biorefineries [99], curriculum proposals in green chemistry [70], and in agriculture and water treatment [98,105]. In art and humanities, proposals were developed which advocated for commitment to the environment and the creation of ecological awareness [56] in actions related with design [18,69]. There were also proposals of models applied to the fashion industry [77,100]. In science, there was research which presented the relationship between CE and IoT [101], and there were also models which proposed activities for training university professors in STEM fields on bioenergy [1].

In health sciences, work was carried out with CE proposals in the field of bioinformatics [55]. Finally, in social and legal sciences, educational proposals were found in entrepreneurship and bioenergy [26], and descriptive articles which worked on accounting education and CE [52], marketing research in the field of bioenergy [93] and circular business based on regenerative economic models [58].

In Figure 9, the relationship is shown between the nature of the data and the discipline in which the research is encompassed. Significant differences in the sets were not observed in any of the checks and keys were not included. However, for checks associated with research encompassed in the discipline of engineering and architecture, the predominant data were continuous quantitative and categorical qualitative data, followed by discrete quantitative and binary qualitative data. The checks in the area of social and legal sciences showed a similar distribution in the data used, with continuous quantitative and categorical qualitative data being predominant, followed by discrete quantitative and binary

qualitative data. The results in the discipline of art and humanities indicated that the predominant data was qualitative, with both categorical and binary data. In science, data was used in all its modalities.

Figure 9. Relationship between the nature of the data and research discipline.

In Figure 10 the results are shown of the relationship between the nature of the data and the type of research. The checks associated with descriptive research that used categorical qualitative data was significant and greater than research that used data of another nature. For checks associated with analytical research, it is shown that binary qualitative data was predominant over other data, in turn observing that studies with discrete quantitative data were predominant over studies which used categorical qualitative data. For checks associated with comparative and participative research, keys were not shown, but both had predominant quantitative data, both discrete and continuous.

Figure 10. Relationship between the nature of the data and type of research.

Finally, presenting the relationship between the nature of the data and the research objective, it was shown that the checks associated with the objectives of characterising,

diagnosing and specifying that used categorical qualitative data presented significant values compared with the other data. For the set of checks associated with research that described and used categorical qualitative data, a significant value was shown compared with research that used discrete and continuous quantitative data, which, in turn presented greater values in research that used binary qualitative data. Additionally, research that detailed, defined, listed, studied, proposed and used categorical qualitative data was greater than that which uses binary qualitative data. For other checks, keys and significant values are not presented.

RQ2.3. Is There a Relationship between the Source of Data and the Research Discipline, Type and Objective?

In Figure 11 the relationship is shown between the source of data and the research disciplines. None of the disciplines presented significant values. The checks associated with the research in the engineering and architecture discipline did not present keys, although the distribution was similar among all types of data. For the set of checks associated with the discipline of social and legal sciences, it is indicated that those that used numerical secondary data were larger than those that used non-numerical primary data. The checks associated with the discipline of art and humanities showed that the research with non-numerical primary and secondary data were greater than those which used numerical secondary data. For the set of checks associated with the discipline of science, it is observed that research with numerical and non-numerical primary data were greater than those that use numerical secondary data. In the discipline of health sciences, no keys were presented.

Figure 11. Relationship between the source of data and research discipline.

In Figure 12 results are shown of the relationship between the source of data and the type of research. For the set of checks associated with descriptive research, it was found that non-numerical secondary data was significant and greater than those which used numerical primary data and numerical secondary data. Additionally, research that used non-numerical primary data was greater than research that used numerical primary data. The checks associated with analytical techniques show that numerical secondary data and

numerical primary data presented greater keys than non-numerical secondary data. For the set of checks associated with comparative research, significant values were presented in the numerical primary data, which were greater than in the rest source of the data. For the set of participative checks, no keys or significant values are presented.

Figure 12. Relationship between the source of data and research type.

Finally, posing the relationship between collecting data and research objectives, no significant values are shown, although it was observed that for the set of checks associated with the objective of analysis that uses numerical primary data, greater values are shown than those which used non-numerical secondary data. For the set of checks associated with the objective of description, it is shown that the studies that used non-numerical primary and secondary data were greater than those that use numerical primary data. The checks associated with the objective of establishing show that numerical primary data followed by non-numerical primary data were predominant compared with non-numerical secondary data.

3.2.4. SO3. Determine the Characteristics of the Samples Used

RQ3.1. What Type of Research Declares the Study Universe?

The universes declared in descriptive research were associated with university students [25] and agents, and stakeholders of education centres [18]. Italian Plants (Waste-to-energy) were also declared as universes [76].

Among the universes declared in analytical research were students from primary school and high school [15,29], university [5,14,84,91] and summer courses [103]. There were also broader universes made up by agents and stakeholders of the education sector [13,79,85]. In the educational spectrum, schools and educational programmes had to be mentioned as universes of some research [28,68]. Notable also among the universes were experts of the business sector [82], bioenergy projects [65,66,80], the industrial sector [89] and academics [34]. Additionally, universes could be found related to scientific documents and publications indexed in databases related with CE and bioenergy [21,59,60]. Digital content, such as websites, were found in the industrial retail sector [90], as well as tweets with related content in bioenergy [22]. Finally, in analytical research, businesses were included as universes [20,64,73,87].

In all comparative research, the study universe was declared. Thus, high school and university students [19,62,88] and agents of SMEs [67] were found as universes.

Declared among study universes in participative research were university students in resource management [61] and milk churn facilities at farms [24].

In Figure 13 the relationship is shown between the study universe and the type of research. For the set of checks associated with descriptive techniques, it is observed that research where the study universe was not declared were significant and greater than those where it was declared. The checks associated with analytical and descriptive techniques which declared the study universe were greater than those which did not do so, also being significant in the case of comparative research.

Figure 13. Relationship between the study universe and research type.

RQ3.2. What Is the Predominant Sampling Technique?

Analysing the results obtained, it can be observed that research which used intentional sampling as a sampling technique was predominant (29.7%) as well as those which did not indicate either the sampling technique or the sample used (29.7%). Less common was research that used structural sampling techniques (10.8%), probabilistic samples (8.1%) or significant populations (2.7%). It must also be mentioned that there was research which did not indicate the type of sample use (18.9%) due to their structural characteristics.

RQ3.3. Is There a Relationship between the Sampling Techniques and the Source of Data, Nature, and Data Collection of the Study?

In Figure 14 the relationship is shown between the sampling techniques and the source of data that the research uses. For the set of checks associated with research that used non-numerical primary data, it is shown that the structural and intentional samples were significant and greater than probabilistic samples, significant samples and those which did not indicate the sample. In checks associated with non-numerical secondary data, it can be observed that research that did not indicate the sample was greater than the rest of the sampling techniques. For the set of checks associated with numerical primary data, the research with intentional sampling was significant compared with significant sampling and where the sample was not indicated. Finally, in the checks associated with secondary data, it was observed that the significant population samples were greater than probabilistic samples compared with other samples. In this case, it should be indicated that the samples were very small.

Figure 14. Relationship between the sampling techniques and the source of data.

In Figure 15 the relationship is shown between the sample techniques and the nature of the data in the research. For the set of checks associated with research that uses categorical qualitative data, it is observed that the research which did not use the sampling method were greater than those which are intentional and probabilistic. In the checks associated with research with discrete quantitative data, it is notable that the intentional samples were significant compared with research in which the sample was not indicated or where it was not applicable. For the set of checks associated with continuous quantitative data, it is observed that the probabilistic research was significant compared with the structural and significant samples and those which did not indicate the sample. Finally, the set of checks associated with binary qualitative data shows that intentional sampling was significant compared with the other types of samples.

Figure 15. Relationship between the sampling techniques and nature of the data.

In Figure 16 the relationship is shown between the sample techniques and the collection of data of research. For the set of checks associated with observed data, it is observed that cases in which the sample was not applicable, significant population samples and those which did not indicate the sample were greater than research that used intentional and structural samples. For the set of checks associated with declared data, it is observed that research with structural samples was greater than intentional samples, which were predominant over probabilistic samples, all being significant compared with other types of samples. In checks associated with experimental data, no keys are presented.

Figure 16. Relationship between the sampling techniques and the data collection.

RQ3.4. Is There Any Relationship between the Area of Study and the Sampling Techniques?

In Figure 17 the relationship is shown between the study areas and the sampling techniques of the research. For the set of checks associated with engineering and architecture research, it is observed that the research wherein which indicating the sample was not applicable, structural samples and intentional samples were greater than probabilistic samples. It is also notable that intentional samples and those where sampling was not applicable were significant. For the set of research associated with social and legal science, there were no significant results, although intentional samples were predominant over research in which indicating the sample was not applicable. In checks associated with art and humanities, intentional samples were significant and predominant over probabilistic and significant population samples. For the set of checks associated with the discipline of science, it is observed that studies in which indicating samples was not applicable were significant and greater than probabilistic and significant samples. In health sciences, keys and significant results are not included in any of the checks.

RQ3.5. Have the Largest Samples under the Sampling Techniques been Selected?

When presenting the relationship between types of samples and sample sizes, no significant results were found in the comparison of proportions. However, it must be noted that research with sample sizes from 1 to 50 that used structural and intentional sampling techniques were greater than the rest of samples. Consistent with the sample size that was not applicable for being indicated, the results presented keys in research with types of sampling which indicated the sample and were not applicable, being greater than the rest of the sampling types.

Figure 17. Relationship between the sampling techniques and area of study.

3.2.5. SO4. Determine the Analysis Techniques Used

RQ4.1 What Are the Predominant Analysis Techniques?

The techniques of qualitative analysis (66.2%) were predominant over quantitative techniques (32.4%) and social network analysis techniques (4.1%). Specifically, notable among the qualitative analysis techniques were techniques by analytical induction (59.5%) compared with more complex techniques such as Grounded Theory (4.1%) or semiotic-structural analysis techniques (2.7%).

Among the quantitative techniques there were no predominant techniques, although the percentages were uniformly distributed among the different types of techniques. In this way, notable studies were multivariant with descriptive statistics (6.8%), bivariable with descriptive statistics (5.4%), multivariable with nonparametric statistics (Mann Whitney) (4.1%), multivariable with factorial analysis (4.1%) and multivariable with variance analysis (1.4%).

Finally, social network analyses, very small in number, used text mining (2.7%) and analysis of sentiment and opinions (1.4%).

RQ4.2. Is There an Association between Analysis Technique (Primary and Secondary) and Research Discipline, Type and Objectives?

In Figure 18 the relationship is shown between analysis techniques and research disciplines. In this case, no significant values were found, but predominant keys were found in the analysis typologies. Thus, for the set of checks associated with the discipline of engineering and architecture, qualitative analysis was greater than quantitative analysis. The checks associated with social and legal sciences showed that research with quantitative analysis was predominant over those which used qualitative analysis. For the set of checks associated with art and humanities, qualitative techniques were predominant over analysis of social networks. Finally, for the discipline of science, it was observed that quantitative and qualitative analysis was more common than those which used analysis of social networks.

Figure 18. Relationship between the analysis techniques and research discipline.

In Figure 19 the relationship is shown between the analysis techniques and type of research. Significant values were not included in any of the proportions. For the set of checks associated with descriptive research, it is observed that studies which undertook a qualitative analysis were greater than those which are quantitative and those which used analysis of social networks. In analytical research, research using social networks was predominant over research carried using quantitative analysis. Additionally, both were predominant over those which used qualitative analysis techniques. For the set of checks associated with comparative techniques, it is observed that the research carried out using research using quantitative analysis was predominant over research using qualitative analysis or social networks. In participative research, keys are not presented.

Figure 19. Relationship between the analysis techniques and type of research.

When presenting the relationship between the analysis techniques and research objectives, it is observed how research that analysed, established or deconstructed was significant in qualitative analysis. Additionally, for the set of checks associated with objectives that described, detailed, characterised, diagnosed or specified, which used qualitative analysis as a technique, were greater than those which used quantitative analysis techniques or social networks.

RQ4.3. Is There Consistency between the Type of Analysis Techniques Used and the Source of Data, Nature and Collection of Data?

In Figure 20 the relationship is shown between analysis techniques and the sources of data of research. For the set of checks associated with research that used non-numerical primary data, it is observed that those which undertook qualitative analysis were significant and predominant over quantitative analysis techniques and analysis of social networks. In checks associated with research that used non-numerical secondary data, significant values were not included, although qualitative techniques were predominant over quantitative techniques. For the set of checks associated with research that used primary data, quantitative analysis techniques exceeded qualitative analysis and social network techniques. Finally, in the checks associated with numerical secondary data, it is observed how the research that used quantitative analysis techniques were greater than those which used analysis techniques by social networks.

Figure 20. Relationship between the analysis techniques and sources of data.

In Figure 21 the relationship is shown between analysis techniques and the nature of data of research. For the set of checks associated with research that used categorical qualitative data, it was found that those which carried out qualitative analysis and analysis of social networks were greater than those which used quantitative analysis. The checks associated with discrete quantitative data and continuous quantitative data showed that those which used quantitative analysis techniques were significant and predominant over qualitative analysis and social network analysis techniques.

In Figure 22 the relationship is shown between the analysis techniques and collection of data from research. For the set of checks associated with declared data, it is observed that analysis by social networks was predominant over qualitative analysis and that both were greater than research which carried out quantitative analysis. Finally, the checks associated with declared data indicate that quantitative analysis was significant and greater than qualitative analysis and analysis by social networks.

Figure 21. Relationship between the analysis techniques and nature of data.

Figure 22. Relationship between the analysis techniques and form of collecting data.

4. Discussion

Circular economy and bioenergy are two potential solutions for avoiding environmental problems, thanks to the simplification of production processes and the usage of renewable energies [7]. Despite their technicality, both areas attract the interest of both institutions and organisations, such as the Ellen Macarthur Foundation [106] and the European Commission [10], and also as a formal object of study of research with areas of study directly linked to the Social and Legal Sciences.

Specifically, as pointed out by Halder et al. [13] and Skjolsvold [33], education, and communication are two areas which, in conjunction with the previous ones, contribute directly to the paradigm shift in production processes and encourage the creation of responsible habits among citizens.

This study evaluated the level of maturity of this area of research by considering the level of methodological formalization of the publications, the examination of the information collection techniques used, the data collected, the characteristics of the samples used, and the analysis techniques applied.

4.1. SO1. Describe the Predominant Information Collection Techniques

With regard to the information collection techniques, studies mostly used a single technique which focused on the selection and evaluation of documents to explore the field of research. As a result, research was not complex and explored, in a descriptive and analytical form, the applicability of proposals and educational and methodological models, using documentary techniques or surveys. These educational models, in combination with active methodologies promote understanding in these areas, eventually simulating real environments for learning. Consistent with Whalen et al. [5], contextualising reality in educational actions allows the learning of students to be enriched, optimising proposals for achieving high levels of knowledge. These studies were proposed from an initial exploratory level and were characterised by contextualisation mainly in educational and academic sectors and, to a lesser extent, in the business sector. As indicated by Sovacool [23], in fields related with energy research, social and cultural factors must be addressed, with work from different areas and perspectives to expand and develop future lines of research. Those aimed at the academic and educational sector are oriented toward ascertaining the opinion of students on these issues and presenting future proposals applicable in the classroom, underscoring the need to take actions aimed at citizen education to achieve a real commitment to the environment and to develop an ecological conscience. Innovative educational proposals are especially emphasised in the literature as novel ways to contribute to sustainable development and the application of CE and bioenergy. Thus, Kirchherr and Piscicelli [25] indicated in their research that carrying out interactive exercises combined with problem-based learning (PBL) methodologies contributed to the teaching principles in these areas. In this sense, Kılıkş and Kılıkş [24] added that innovative actions help empowerment and deep understanding of CE among students. To achieve a specialised vision, opinions were gathered from informed subjects such as experts, agents and stakeholders, reinforcing the idea of transition toward CE and the implementation of sustainable models. The research by Grzyb et al. [80] agreed that using experts to gather information on bioenergy helps to obtain qualitative and quantitative results.

4.2. SO2 Identify the Typology of the Data Collected

With regard to the typology of data that the studies used, the homogeneous use of different types of data indicated that research was focused on a preliminary research phase. Data of diverse typologies were gathered, mostly contextualised in the disciplines of engineering and architecture, and social and legal sciences.

Thus, both Saito [20] and Andrews [8] used qualitative categorical data in their research to theoretically address CE.

In their research, Fujii et al. [14] collected discrete quantitative data, focusing on educational models that used bioenergy and fostered proper judgment among students. They agree with Özbas [15] in the use of this type of data to foster students' critical awareness of the environment.

Rodriguez-Chueca et al. [91] fostered environmental competencies in STEM areas among university students using continuous qualitative data. In addition, Esparragoza and Mesa-Cogollo [97] collected these kinds of works with sustainable models and products within the educational field.

Prieto-Sandoval et al. [82] collected binary qualitative data to study the strategic implementation of CE in the business environment and to collect information from policymakers. Celades et al. [79] also gathered them to evaluate the sustainable use of infrastructures within the educational institutional environment field.

It is notable that non-numerical qualitative data obtained from observation and collection of declarations was predominant, which indicates consistency between collection techniques and the typology of the data used.

Additionally, this methodological consistency could be observed by presenting the relationship between the nature, purpose and type of research, as qualitative data is descriptive while quantitative data is notable for its analytical character.

In the analytical section, Halder et al. [13] researched in the field of Education for Sustainable Development (ESD) to measure the perception and knowledge of teachers. Thus, numerical primary data and non-numerical primary data were obtained by means of surveys and, consequently, their nature was discrete quantitative data, binary qualitative data, and categorical qualitative data.

The research by Whalen et al. [5] is an example of the consistency found in these research results. Contextualized in the educational field, it worked on the basis of a game to encourage reflections on CE. Thus, it was of analytical nature and gathered categorical qualitative, non-numerical primary data. Consequently, the results offered in their research were based on the students' qualitative statements and reached more consistent conclusions than in other studies.

4.3. SO3. Determine the Characteristics of the Samples Used

In terms of the characteristics of samples used in the research, it was positioned in sizes and sampling types which were assumable and manageable by the researchers in the context of work with limited scope.

In addition, the results indicate that most of the samples were positioned in the educational field. In the work of Hall and Velez-Colby [18], research students were allowed to work on different disciplines of CE, motivating them and stimulating their critical thinking. Thus, as Kirchherr and Piscicelli [25] pointed out that developing courses and educational interventions allows students to be introduced to topics related to CE.

Although studies were found with large samples, the sampling procedures were basic and needed to be developed to be able to generalise and extrapolate the results to the rest of the population. Thus, the sampling procedures were limited, notable for intentional and structural samples, characterised by their ease of collection compared with probabilistic and significant population samples.

In line with this finding, the research of Halder et al. [19] used large samples that allowed developing comprehensive studies to measure the perception of students towards the use of bioenergy.

In line with the bibliometric study of Nobre and Tabares [59], the usage of a high number of publications allowed the acquisition of more detailed results and to approach in depth the scope of the CE addressed from Big Data and the Internet of Things.

Additionally, it can be observed that in descriptive research, the study universe was not declared, with narrative models not going into great detail or elaborating on the methodological techniques of the research. However, it should be highlighted that the established samples corresponded with the targets of the research, the academic and educational sector and business fields once more being notable.

4.4. SO4. Determine the Analysis Techniques Used

With regard to the analysis techniques, the simplicity of the research could be checked, as qualitative techniques were mostly predominant, using analytical induction focused on undertaking literature reviews or documentary studies, compared with more complex statistical reviews which require specific data for undertaking more elaborate analytical processes.

This finding is in line with Williams et al. [69]. In their research, they descriptively reviewed Educational Sustainable Development (ESD) strategies in projects. Askoxylakis [101] also defined and characterized the novel ways of interaction between the Circular Economy and the Internet of Things.

In both cases, the conclusions obtained were limited to a descriptive level, due to the lack of information collection systems that allowed the development of more in-depth analysis techniques.

A notable aspect is that studies presented a methodological consistency between the source of data collection and the analysis techniques; that is, qualitative studies used non-numerical data and quantitative research used numerical data.

5. Conclusions

The systematic literature review carried out allows the conclusion that research on CE and bioenergy from the perspective of communication and education had a low level of methodological formalisation in terms of information collection techniques, typology of data, characteristics of samples and analysis techniques.

The collection techniques were simple, characterised by evaluating and selecting proposals based on scientific literature and conversations with subjects involved with and informed about processes related to CE and bioenergy.

The typology of the data collected contributed to reinforcing and establishing that the research is in an initial exploratory stage. As a conclusion, the characteristics of the samples used revealed the need to continue undertaking more complex research with larger samples and more effective sampling techniques, to be able to reach conclusions with a higher level of confidence and reliability.

The analysis techniques used suggest that there was rigour in the analytical procedures and that they were appropriate for the type of research being presented. However, as with the information collection techniques, the studies presented a single analysis technique which showed that, in the majority of cases, they were working at an initial level of an exploratory study.

This research undertook a systematic literature review accompanied by a qualitative and quantitative analysis process. Thus, following the PRISMA model, the level of methodological formalisation of the collected research was identified and subsequently analysed in-depth. The studies which worked on issues of CE and bioenergy from the field of communication and education were in an initial stage, which must be explored in future research. Although the research concludes that the level of formalisation of the area is in an initial stage, it should be indicated that the sample selection could have led to some cases of documentary silence, despite having involved collecting scientific literature from the most representative databases.

The PRISMA statement allows tackling a systematic literature review and a meta-analysis of the circular economy and bioenergy addressed by the education and communication field. As demonstrated in this study, this is useful when retrieving emerging literature due to its organized phases.

Authors might take into account that this protocol depends on who analyses the data, so that it is highly recommended to replicate this by several researchers. As a result, biases and unclear outcomes are avoided.

For undertaking future research, the possibility of studying other dimensions of the selected articles is presented. Additionally, a similar study must be carried out to observe how the publications have evolved, and to ascertain the relevance of an emerging area which provides solutions aimed at citizen awareness and education on the environment.

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Appendix A

- “urban biowastes” AND (“advertising” OR “communication” OR “communications” OR “media” OR “digital” OR “marketing” OR “effectiveness” OR “engagement” OR “education” OR “higher education” OR “persuasion” OR “memory” OR “credibility” OR “attention” OR “motivation” OR “ux” OR “user experience” OR “experience” OR “eye-tracking” OR “eye tracking” OR “usability” OR “digital content” OR “cross media” OR “transmedia” OR “360° video”)
- “circular economy” AND (“advertising” OR “communication” OR “communications” OR “media” OR “digital” OR “marketing” OR “effectiveness” OR “engagement” OR “education” OR “higher education” OR “persuasion” OR “memory” OR “credibility” OR “attention” OR “motivation” OR “ux” OR “user experience” OR “experience” OR “eye-tracking” OR “eye tracking” OR “usability” OR “digital content” OR “cross media” OR “transmedia” OR “360° video”)
- “chemical biobased products” AND (“advertising” OR “communication” OR “communications” OR “media” OR “digital” OR “marketing” OR “effectiveness” OR “engagement” OR “education” OR “higher education” OR “persuasion” OR “memory” OR “credibility” OR “attention” OR “motivation” OR “ux” OR “user experience” OR “experience” OR “eye-tracking” OR “eye tracking” OR “usability” OR “digital content” OR “cross media” OR “transmedia” OR “360° video”)
- “bioenergy” AND (“advertising” OR “communication” OR “communications” OR “media” OR “digital” OR “marketing” OR “effectiveness” OR “engagement” OR “education” OR “higher education” OR “persuasion” OR “memory” OR “credibility” OR “attention” OR “motivation” OR “ux” OR “user experience” OR “experience” OR “eye-tracking” OR “eye tracking” OR “usability” OR “digital content” OR “cross media” OR “transmedia” OR “360° video”)
- “biorefinery” AND (“advertising” OR “communication” OR “communications” OR “media” OR “digital” OR “marketing” OR “effectiveness” OR “engagement” OR “education” OR “higher education” OR “persuasion” OR “memory” OR “credibility” OR “attention” OR “motivation” OR “ux” OR “user experience” OR “experience” OR “eye-tracking” OR “eye tracking” OR “usability” OR “digital content” OR “cross media” OR “transmedia” OR “360° video”)
- “urban biowaste” AND (“advertising” OR “communication” OR “communications” OR “media” OR “digital” OR “marketing” OR “effectiveness” OR “engagement” OR “education” OR “higher education” OR “persuasion” OR “memory” OR “credibility” OR “attention” OR “motivation” OR “ux” OR “user experience” OR “experience” OR “eye-tracking” OR “eye tracking” OR “usability” OR “digital content” OR “cross media” OR “transmedia” OR “360° video”)

Appendix B

- “urban biowastes” AND (“children” OR “education” OR “communication” OR “media literacy” OR “disinformation” OR “distance-learning” OR “e-learning” OR “information technology” OR “Information Communication Technology” OR “internet” OR “learning” OR “research” OR “school” OR “media” OR “social media” OR “social network” OR “student” OR “college students” OR “communication education” OR “learning experiment”)
- “circular economy” AND (“children” OR “education” OR “communication” OR “media literacy” OR “disinformation” OR “distance-learning” OR “e-learning” OR “information technology” OR “Information Communication Technology” OR “internet” OR “learning” OR “research” OR “school” OR “media” OR “social media” OR “social network” OR “student” OR “college students” OR “communication education” OR “learning experiment”)
- “chemical biobased products” AND (“children” OR “education” OR “communication” OR “media literacy” OR “disinformation” OR “distance-learning” OR “e-learning” OR “information technology” OR “Information Communication Technology” OR “internet” OR “learning” OR “research” OR “school” OR “media” OR “social media” OR “social network” OR “student” OR “college students” OR “communication education” OR “learning experiment”)
- “bioenergy” AND (“children” OR “education” OR “communication” OR “media literacy” OR “disinformation” OR “distance-learning” OR “e-learning” OR “information technology” OR “Information Communication Technology” OR “internet” OR “learning” OR “research” OR “school” OR “media” OR “social media” OR “social network” OR “student” OR “college students” OR “communication education” OR “learning experiment”)
- “biorefinery” AND (“children” OR “education” OR “communication” OR “media literacy” OR “disinformation” OR “distance-learning” OR “e-learning” OR “information technology” OR “Information Communication Technology” OR “internet” OR “learning” OR “research” OR “school” OR “media” OR “social media” OR “social network” OR “student” OR “college students” OR “communication education” OR “learning experiment”)
- “urban biowaste” AND (“children” OR “education” OR “communication” OR “media literacy” OR “disinformation” OR “distance-learning” OR “e-learning” OR “information technology” OR “Information Communication Technology” OR “internet” OR “learning” OR “research” OR “school” OR “media” OR “social media” OR “social network” OR “student” OR “college students” OR “communication education” OR “learning experiment”)

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