


Article

Municipal Waste Recycling Customer Education and Communication in Slovenia and Croatia

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Abstract: The aim of this paper is twofold: (a) to present the existing regional research related to customer education and communication in municipal waste recycling from the viewpoint of a comparative bibliometric analysis and (b) to illustrate how municipal waste recycling practices in the two countries mirror the theoretical trends identified in the literature and the EU institutional and policy requirements. We discuss the practical implementation of municipal waste recycling practices in the two European countries and provide practical recommendations for local governments, municipal companies, and other stakeholders of the municipal waste management process.

Keywords: municipal waste management; recycling; pro-environmental behavior; Slovenia; Croatia; Europe



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1. Introduction

The purpose of this article is to evaluate recent practices of municipal waste recycling in Croatia and Slovenia from the viewpoints of recent scientific research in the field and the applicable EU policies, which require authorities and utility companies to respond to the sustainable development imperatives [1]. The corporate sector is expected to contribute to environmental sustainability for an extended period, either as a part of Corporate Social Responsibility (CSR) initiatives [2], or other related agendas, including corporate citizenship, stakeholder management, and business ethics [3]. In addition, sustainability reporting has been established as a separate field within the accounting, finance, and performance management literature [4–6], and includes the analysis of the impact of sustainability on corporate performance [7–9].

In addition, it is now an increasingly common expectation that the public [10,11] and non-profit [12] sectors contribute to sustainable development, which further extends to the pro-environmental behavior of citizens [13,14], with a special focus on recycling and other forms of reducing urban waste [15,16]. This issue is especially relevant as a high quantity of excess medical waste and used personal protection equipment, such as medical masks, was produced during the COVID-19 pandemic [17].

We are especially interested in how municipal waste management and recycling issues could be communicated to customers (end users) of local utility companies. Some of them might even need to be educated on the correct way to perform recycling, since waste contamination (i.e., mixing of different categories of waste and recycling of uncleaned containers) presents one of the most important and long-lasting challenges to recycling municipal waste [18]. In the literature, some of the recycling supply-side-related problems and potential solutions have already been identified, as related to the optimization of municipal waste recycling centers' operations [19] and the selection of recycling vs. other reusing options [20].

On the other hand, demand-side solutions intended to influence consumer/citizen attitudes and behavior related to producing and recycling municipal waste have also

been discussed in the extant literature. Communication and behavior interventions with inhabitants of multi-family dwellings were explored by DeYoung et al. with the aim to increase recycling rates [21]. The role of informal recycling systems, which prove to be especially effective in developing countries, was analyzed by Wilson, Velis, and Cheesman [22], and by Wilson et al. [23]. In addition, Catlin et al. [24] discussed the labeling of waste and recycling bins, including unwanted effects (e.g., consumers' attempts to recycle unrecyclable items).

This literature does not typically consider the EU institutional and policy context in terms of creating pressure for increased optimization and recycling of municipal waste, and it does not reflect the local research interests in this topic. However, the role of municipal waste specialist research literature and the role of communication and education of (utility companies') customers in achieving higher recycling rates need to be confirmed by a relevant scientific analysis. Our paper addresses this issue in the second section, where the regional (Slovenian and Croatian) research on the previously described topic is placed in the context of the global waste management literature using bibliometric methods (see Section 2.3). In this way, the contribution of the regional research community to the discussion of the waste management topic can be evaluated and recognized. In addition, we evaluate the contribution of regional research in terms of providing inputs to the waste management and recycling industry in the region (see Section 2.4) and provide recommendations for their cooperation.

In the third section, we present the EU policy context of municipal waste recycling to describe the pressures placed on utility companies engaged in promoting the recycling of municipal waste. The fourth section provides a discussion of waste recycling-related practices from Slovenia and Croatia, with a focus on retail product packaging. Some of the discussed practices could serve as both generalizable propositions for further research and a framework for action for municipal utility companies dealing with waste management. The paper is concluded with a fifth section, which consists of the research discussion and implications for utility companies, while the concluding remarks (in the last section) present the potential for generalizations and further research.

2. A Bibliometric Overview of the Global and Regional Waste Management Literature

In analogy with the previous research on economic and sustainability issues in higher education [25], the bibliometric approach was used to describe the previous research in the field of waste management. We first analyzed the global multi-disciplinary field of municipal waste management, and the related scientific output of Slovenian and Croatian researchers. Different bibliometric indicators were used to describe the field. Out of many different approaches that could be used for such a purpose, we chose to analyze Elsevier Scopus-indexed publications due to their high-quality data and extensive coverage of the technical and social science fields, books, book chapters, and conference proceedings. In addition, they have extensive coverage of social science research when compared to alternative citation databases, such as Clarivate Web of Science [26]. This fact is especially significant when discussing the customer-related aspects of environmental issues, which are usually analyzed in the fields of economics and business, or applied psychology. Elsevier SciVal is the software tool of choice for reporting, benchmarking, and analyzing bibliometric data [27], including summarizing research in specific scientific fields and topics.

2.1. Waste Management Literature: Global, Slovenian, and Croatian Literature

To describe the municipal waste management literature, we used the default ASJC (All Scopus Journal Categories) classification, listing the Waste Management and Disposal topic, within the Environmental Science parent category. In this section, we provide an overview of scientific productivity and the impact on the research output of the observed scientific topic according to the analysis of the global CSR literature, using the same methodology and data sources [28].

The reason for analyzing a five-year literature window can be found in the average research project length, as discussed by Körfggen et al. [29]. In the five years preceding the writing of this paper (2017–2021), this research area consisted of 135,203 publications, with increasing interest from researchers as the scholarly output increased from 20,453 publications in 2017 to 35,011 in 2021. The total number of citations in the observed five-year period equaled 2,431,682. Since the research area of waste management is multi-disciplinary, the citation data needed to be normalized due to the different citation patterns across scientific fields [30]. Elsevier SciVal favors the use of a simple normalized citation metric, demonstrating the number of citations relative to the value of 1.0, which represents the global normalized average for all scientific fields, indexed by Scopus. Values lower than 1.0 represent a lower level of scientific impact, while values higher than 1.0 represent a higher level of scientific impact, compared to the global average. This metric is called the Field-Weighted Citation Impact (FWCI) and can be used for easy benchmarking of research impact in multi-disciplinary scientific fields [31]. The average FWCI metric value for the observed scientific topic was 1.19 (for the entire 2017–2021 period), increasing from 1.07 in 2017 to 1.27 in 2021. The number of papers, featuring researchers' international collaboration, equals 37,125 for the entire period, increasing from 4887 in 2017 to 10,109 in 2021.

The geographical distribution of the scholarly output (see Figure 1) shows the countries with the highest scholarly output and impact.



Figure 1. Geographic distribution of scholarly output and research impact for the observed topic. **Note:** The legend above shows the amount of scholarly output, while the numbers on the map represent the normalized research impact for the national research of the observed scientific topic, measured using the FWCI metric. **Source:** Elsevier SciVal (December 2022).

Visualization of the national scientific activity in Europe, with a focus on the regions of Central and Eastern Europe (CEE) and South East Europe (SEE), is provided in Figure 2, with a Slovenian scholarly output of 334 papers with 6561 citations, and an FWCI-normalized impact value of 1.23 and 221 publications published in collaboration with international researchers (for the entire 2017–2021 period). In the same period, Croatian researchers produced 301 papers, attracting 4447 citations, with an FWCI value of 0.96 and 189 publications featuring international collaboration.

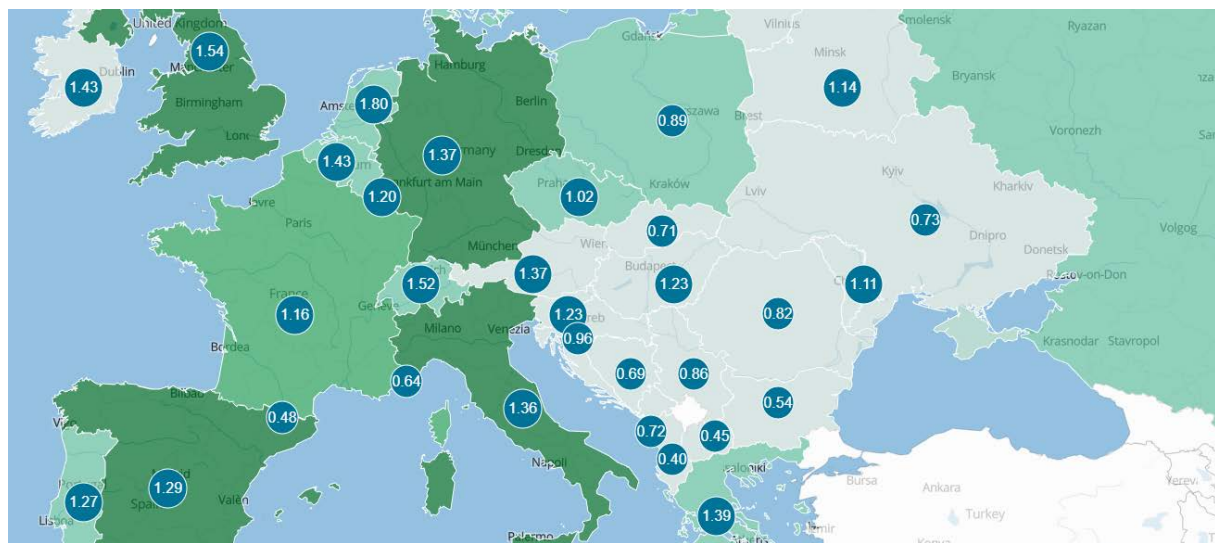


Figure 2. Geographic distribution of scholarly output and research impact for the observed topic, with a focus on CEE and SEE regions. **Note:** See the note below Figure 1 for methodological details. **Source:** Elsevier SciVal (December 2022).

The top 25 European countries according to scholarly output in the field for the 2017–2021 period are presented in Table 1, where Slovenia holds the 24th and Croatia the 25th position. While the scholarly impact is similar, Slovenian researchers have an above-average scientific impact (with an FWCI value of 1.23) and Croatian researchers a slightly below-average impact (with an FWCI value of 0.96).

Table 1. Scholarly output and research impact for the observed topic in the top 25 European countries *.

	Country/Region	Scholarly Output	FWCI	Citation Count
1.	United Kingdom	5995	1.54	143,585
2.	Spain	5896	1.29	122,601
3.	Italy	4986	1.36	99,057
4.	Germany	4854	1.37	104,133
5.	France	4060	1.16	75,335
6.	Poland	2512	0.89	34,647
7.	Russian Federation	2416	0.55	15,733
8.	Netherlands	2293	1.8	67,598
9.	Sweden	1938	1.43	44,903
10.	Portugal	1901	1.27	42,591
11.	Denmark	1585	1.67	40,658
12.	Belgium	1524	1.43	36,540
13.	Switzerland	1436	1.52	36,236
14.	Greece	1418	1.39	31,303
15.	Czech Republic	1267	1.02	19,843
16.	Finland	1262	1.36	27,417
17.	Austria	1057	1.37	22,881

Table 1. *Cont.*

Country/Region	Scholarly Output	FWCI	Citation Count
18. Norway	998	1.63	24,331
19. Romania	833	0.82	8034
20. Ireland	737	1.43	18,590
21. Slovakia	506	0.71	5588
22. Serbia	444	0.86	5723
23. Hungary	381	1.23	7655
24. Slovenia	334	1.23	6561
25. Croatia	301	0.96	4447

* Source: Elsevier SciVal (December 2022).

Most of the most productive and influential universities and other research institutions in the field are located in China (see Table 2), with seven non-Chinese institutions in the top 25. As evident from Tables 2 and 3, none of the research institutions from the CEE and SEE regions is among the leading institutions in the observed field, either globally, or in Europe.

Table 2. Top 25 global research institutions in the observed field, as per scholarly output and impact *.

Institution	Country/Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
Chinese Academy of Sciences	China	6575	1.59	164,331
University of Chinese Academy of Sciences	China	3042	1.57	75,684
CNRS	France	2103	1.2	40,424
Tsinghua University	China	2086	1.87	62,424
CSIC	Spain	1391	1.36	30,524
Beijing Normal University	China	1368	1.89	39,898
Tongji University	China	1358	1.78	36,605
Zhejiang University	China	1321	1.54	31,142
CAS—Research Center for Eco-Environmental Sciences	China	1257	1.47	29,051
Peking University	China	1252	1.9	37,294
Harbin Institute of Technology	China	1238	1.82	34,783
Nanjing University	China	953	1.84	28,528
Ministry of Agriculture of the People's Republic of China	China	943	1.73	23,820
INRAE	France	874	1.27	19,539
South China University of Technology	China	847	1.37	17,659
Universidade de São Paulo	Brazil	803	0.95	12,449
Sun Yat-Sen University	China	801	1.61	19,683
Shanghai Jiao Tong University	China	781	1.83	21,763
Tianjin University	China	761	1.59	18,555

Table 2. *Cont.*

Institution	Country/ Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
United States Department of Agriculture	United States	744	1.02	12,936
Chongqing University	China	705	1.87	19,357
China Agricultural University	China	703	1.78	19,633
University of Queensland	Australia	699	1.84	20,523
Northwest Agriculture and Forestry University	China	693	2.17	22,738
National Research Council of Italy	Italy	672	1.5	15,980

* Source: Elsevier SciVal (December 2022).

Table 3. Top 25 European research institutions in the observed field, as per scholarly output and impact *.

Institution	Country/ Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
CNRS	France	2103	1.2	40,424
CSIC	Spain	1391	1.36	30,524
INRAE	France	874	1.27	19,539
National Research Council of Italy	Italy	672	1.5	15,980
Wageningen University & Research	Netherlands	608	2.07	21,771
Technical University of Denmark	Denmark	576	1.7	15,721
Institut de recherche pour le développement	France	543	1.35	11,375
Delft University of Technology	Netherlands	485	1.64	12,382
Aarhus University	Denmark	482	1.53	11,768
Ghent University	Belgium	474	1.55	13,304
Tomsk Polytechnic University	Russian Federation	469	0.29	1659
University of Porto	Portugal	466	1.33	11,687
University of Lisbon	Portugal	443	1.27	9866
University of Aveiro	Portugal	440	1.4	11,168
Russian Academy of Sciences	Russian Federation	433	0.67	3210
Swiss Federal Institute of Technology Zurich	Switzerland	404	1.63	10,238
Swedish University of Agricultural Sciences	Sweden	403	1.47	10,526
Commissariat à l'énergie atomique et aux énergies alternatives	France	390	0.88	4394
Université Fédérale Toulouse Midi-Pyrénées	France	365	1.14	7637

Table 3. Cont.

Institution	Country/ Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
CSIC—Institute of Environmental Assessment and Water Research	Spain	363	1.71	10,111
Karlsruhe Institute of Technology	Germany	360	1.22	6440
Helmholtz Centre for Environmental Research	Germany	355	1.52	9762
Polish Academy of Sciences	Poland	347	1.18	6974
University of Nottingham	United Kingdom	345	2.22	10,908
Autonomous University of Barcelona	Spain	335	1.36	8157

* Source: Elsevier SciVal (December 2022).

Out of the top 25 European institutions, only one (the Polish Academy of Sciences) is located in the CEE region. None of the Slovenian or Croatian research institutions belongs to the top 100 European institutions, according to scholarly output and impact.

The list of Slovenian and Croatian institutions in the analyzed scientific field ranked according to scholarly output and scientific impact (measured by the FWCI value) is presented in Table 4. The top five institutions in the two countries are the large and established public universities of Zagreb and Ljubljana and three national research institutes (Jožef Stefan, Ruđer Bošković, and the Slovenian National Institute of Biology). The annual scholarly outputs are much smaller than for leading European and global institutions, which was expected as this research metric is directly related to the institution size and can also depend on funding levels. However, both the absolute citation counts and the normalized (relative) impact (as measured by the FWCI indicator) show that the majority of Croatian and Slovenian institutions are below the European and global research performance level in the observed scientific field.

Table 4. Slovenian and Croatian research institutions in the observed field, ranked per scholarly output and impact *.

Institution	Country/ Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
University of Zagreb	Croatia	158	1.01	2426
J. Stefan Institute	Slovenia	112	1.13	2301
University of Ljubljana	Slovenia	112	1.32	2126
Ruder Boskovic Institute	Croatia	65	1.16	1417
National Institute of Biology Ljubljana	Slovenia	32	1.37	761
University of Maribor	Slovenia	32	1.27	663
Josip Juraj Strossmayer University of Osijek	Croatia	31	0.73	350
National Institute of Chemistry Ljubljana	Slovenia	23	1.44	502
University of Nova Gorica	Slovenia	23	1.16	366
Institute of Oceanography and Fisheries	Croatia	14	1.05	103
Institute for Medical Research and Occupational Health	Croatia	13	0.77	169
University of Primorska	Slovenia	12	0.82	132

Table 4. Cont.

Institution	Country/ Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
University of Split	Croatia	10	1.32	105
Slovenian Forestry Institute	Slovenia	9	0.86	107
University of Rijeka	Croatia	8	0.95	81
Scientific Research Centre of the Slovenian Academy of Sciences and Arts	Slovenia	5	0.51	44
Industrija Nafta d.d.	Croatia	5	0.94	45
University of Dubrovnik	Croatia	4	1.96	49
University of Zadar	Croatia	3	0.55	26
Agricultural Institute of Slovenia	Slovenia	2	0.83	35
Institute of Oncology Ljubljana	Slovenia	2	0.77	25
Catholic University of Croatia	Croatia	2	0.64	24
Croatian Academy of Sciences and Arts	Croatia	2	0.6	28
Croatian National Institute of Public Health	Croatia	2	0.43	9
Hrvatska Elektroprivreda	Croatia	2	0.73	27
University North	Croatia	2	0.19	4
TECOS Slovenian Tool and Die Development Centre	Slovenia	1	0.11	2
Croatian Veterinary Institute	Croatia	1	0	0
Croatian Waters	Croatia	1	0.88	7
Elektroprojekt	Croatia	1	0.26	14
Oikon Ltd.—Institute of Applied Ecology	Croatia	1	0.81	1
Split University Hospital	Croatia	1	0.79	13

* Source: Elsevier SciVal (December 2022).

The top 25 individual Slovenian and Croatian researchers ranked per scientific output and impact in the observed field and the values of their bibliometric performance indicators are presented in Table 5.

Table 5. Top 25 Slovenian and Croatian researchers in the observed field, ranked per scholarly output and impact *.

Author	Affiliation	Country/ Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
Duić. Neven	University of Zagreb	Croatia	18	1.78	321
Heath. Ester	J. Stefan Institute	Slovenia	17	1.98	812
Milačič. Radmila	J. Stefan Institute	Slovenia	12	1.86	448
Zuliani. Tea	J. Stefan Institute	Slovenia	10	1.13	232
Heath. David J.	J. Stefan Institute	Slovenia	9	1.76	293

Table 5. Cont.

Author	Affiliation	Country/ Region	Scholarly Output	Field-Weighted Citation Impact	Citation Count
Sandak. Jakub	University of Primorska	Slovenia	9	0.72	19
Pukšec. Tomislav	University of Zagreb	Croatia	9	0.76	27
Hélix-Nielsen. Claus	University of Maribor	Slovenia	8	1.46	190
Kutnar. Andreja	University of Primorska	Slovenia	8	0.78	16
Sandak. Anna	University of Primorska	Slovenia	8	0.78	16
Snoj. Luka	J. Stefan Institute	Slovenia	8	0.33	40
Železnik. Nadja	Milan Vidmar Electric Power Research Institute	Slovenia	8	0.52	44
Ahel. Marijan	Ruder Boskovic Institute	Croatia	8	2.55	472
Vujanović. Milan	University of Zagreb	Croatia	8	1.56	221
Filipič. Metka	National Institute of Biology Ljubljana	Slovenia	7	2.21	238
Humar. Miha	University of Ljubljana	Slovenia	7	0.58	68
Kosjek. Tina	J. Stefan Institute	Slovenia	7	1.45	164
Likožar. Blaz	National Institute of Chemistry Ljubljana	Slovenia	7	2.1	201
Močnik. Griša	University of Nova Gorica	Slovenia	7	2.18	267
Ščančar. Janez	J. Stefan Institute	Slovenia	7	1	152
Žegura. Bojana	National Institute of Biology Ljubljana	Slovenia	7	1.96	214
Atanasova. Nataša	University of Ljubljana	Slovenia	6	2.08	132
Božnar. Marija Zlata	MEIS d.o.o.	Slovenia	6	0.41	16
Grašič. Boštjan	MEIS d.o.o.	Slovenia	6	0.41	16

* Source: Elsevier SciVal (December 2022).

2.2. Analysis of Specialist Literature in Slovenia and Croatia: Customer Communication and Education in Waste Management

As we are especially interested in the specialist literature focusing on customer communication and education in the field of municipal waste management, we developed the following advanced Scopus query, which describes the research topic and limits the scholarly output to Slovenia and Croatia for the 2017–2021 period. As demonstrated by the advanced Scopus query shown below, the search terms “customer communication”, “customer education”, “consumer communication”, or “consumer education”, followed by keywords “waste management”, “waste disposal”, and all forms of the word “recycling” were used to identify the specialist literature authored by Croatian and Slovenian researchers:

TITLE-ABS-KEY (customer* OR consumer* OR communication OR education) AND TITLE-ABS-KEY (“waste” OR “municipal waste” OR “waste management” OR “waste disposal” OR “recycl*”) AND (LIMIT-TO (AFFILCOUNTRY, “Croatia”) OR LIMIT-TO (AFFILCOUN-

TRY, “Slovenia”)) AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017)).

By running the advanced search on the Elsevier Scopus database, 66 documents were identified and downloaded as an Excel CSV file with full bibliometric details. After manual checks for the correct extraction of bibliometric data and the manuscript relevance, one duplicate record and 40 manuscripts were removed manually from the dataset, as they did not belong to the waste management topic or any scientific fields related to sustainability and sustainable development. These were selected by the previously presented keyword query, but did not thematically belong to the intended research corpus. The final dataset (consisting of papers that are electronically available in the additional Supporting Material to this manuscript) was transferred to Elsevier SciVal for further analysis.

There were 96 authors contributing to this specialist literature, which attracted 309 citations (i.e., 12.4 citations per publication), with a total normalized citation value of 1.73 as measured by the FWCI value (i.e., above the global normalized benchmark value of 1.0). Most documents were published in the Scopus Q1 journal quartile (59.1%), followed by 18.2% in Q2, 18.2% in Q3, and 4.5% in Q4 journal quartiles. As compared to other research in the environmental and sustainability scientific fields, the analyzed body of literature also proved to be multi-disciplinary (see Figure 3), with the total sum of percentages related to scientific areas exceeding 100%, as the majority of analyzed publications were classified in multiple research fields.

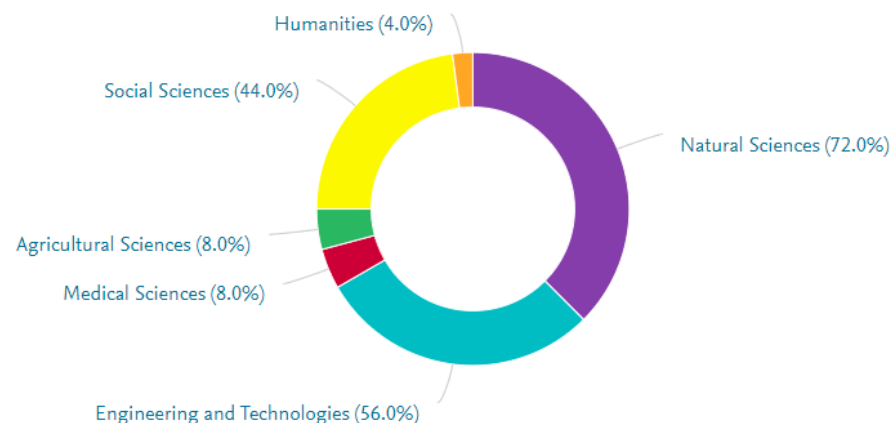


Figure 3. Share of analyzed publications per major scientific subject areas. **Source:** Elsevier SciVal (February 2023).

Journals that published the analyzed research included Journal of Cleaner Production (published by Elsevier), Sustainability (published by MDPI), and several other research outlets (see Table 6). Journal metrics included:

- Source-Normalized Impact per Paper (SNIP), calculated similarly to the FWCI metric: the average journal citation rate divided by the average number of citations expected in the journal field [32];
- CiteScore (2021 value), i.e., the average annual number of citations per document in a journal, received for documents published in the three previous years [33];
- SCImago Journal Rank (SJR) metric, which assesses the quality and reputation of the citing sources [34].

Table 6. Scopus sources publishing the specialist literature on customer communication and education in waste management in Slovenia and Croatia (2017–2021) *.

Scopus Source	Scholarly Output	Citations	Authors	Citations per Publication	SNIP	CiteScore 2021	SJR
Sustainability	3	25	20	8.3	1.31	5	0.664
Journal of Cleaner Production	2	78	6	39	2.444	15.8	1.921
Journal of Environmental Management	1	12	7	12	1.907	11.4	1.481
Resources, Conservation and Recycling	1	8	4	8	2.943	17.9	2.589
Energy	1	28	7	28	2.038	13.4	2.041
Traditiones	1	4	2	4	0.905	1.6	0.26
Materials	1	16	7	16	1.137	4.7	0.604
Rudarsko Geolosko Naftni Zbornik	1	1	1	1	0.876	2.7	0.434
British Food Journal	1	12	3	12	0.984	4.3	0.609
Energy Sources, Part A: Recovery, Utilization and Environmental Effects	1	5	3	5	0.696	4.6	0.432
Mljekarstvo	1	11	6	11	0.583	1.7	0.2
Zdravstveno Varstvo	1	2	3	2	0.703	2	0.347
Land	1	17	4	17	1.294	3.2	0.685
Materials Science and Engineering: Concepts, Methodologies, Tools, and Applications	1	0	3	0	0	0	0
Processes	1	13	3	13	0.889	3.5	0.474
Printed Electronics: Technologies, Applications and Challenges	1	1	6	1	0	0	0
Business Systems Research	1	1	3	1	0.695	2.1	0.265
Jahr	1	8	3	8	0.12	0.3	0.151
Journal of Facade Design and Engineering	1	3	3	3	0.626	2.7	0.385
Environments—MDPI	1	6	4	6	1.216	5.2	0.654
Civil Engineering Journal (Iran)	1	25	1	25	2.632	3.6	0.981
Plastic Waste and Recycling: Environmental Impact, Societal Issues, Prevention, and Solutions	1	33	1	33	0	0	0

* Source: Elsevier SciVal (January 2023).

Table 7 presents research institutions in Slovenia and Croatia with active authors in the examined specialist literature along with the bibliometric indicators of research productivity and impact. It was expected that large public universities (Ljubljana, Maribor, and Primorska in Slovenia, and Zagreb in Croatia) serve as hubs for this specialized research. However, many international institutions are also included in Table 7 due to the international collaboration on the topic. The amount of collaboration is rather extensive, with

32% of the examined corpus (eight publications) produced in international collaboration, 24% (six publications) in national collaboration, and an additional 24% (six publications) in institutional collaboration.

Table 7. Institutional affiliations of researchers contributing to specialist literature on customer communication and education in waste management in Slovenia and Croatia (2017–2021) *.

Institution	Country/ Region	Scholarly Output	Citations	Authors	Citations per Publication	Field-Weighted Citation Impact
University of Zagreb	Croatia	12	153	27	12.8	2.04
University of Ljubljana	Slovenia	2	5	6	2.5	1.1
University of Maribor	Slovenia	2	24	3	12	1.64
University of Primorska	Slovenia	2	18	2	9	1.59
Scientific Research Centre of the Slovenian Academy of Sciences and Arts	Slovenia	2	8	4	4	1.49
Polytechnic Institute of Viseu	Portugal	2	16	4	8	1.23
Aalborg University	Denmark	1	28	2	28	0.7
Josip Juraj Strossmayer University of Osijek	Croatia	1	2	1	2	0.14
University of Rijeka	Croatia	1	8	1	8	0.4
University of Split	Croatia	1	12	1	12	1.58
National Research Council of Italy	Italy	1	16	2	16	1.23
Sant’Anna School of Advanced Studies	Italy	1	8	3	8	1.32
University of Palermo	Italy	1	28	1	28	0.7
Lithuanian University of Health Sciences	Lithuania	1	10	1	10	1.86
Wroclaw University of Environmental and Life Sciences	Poland	1	10	1	10	1.86
University of Porto	Portugal	1	10	1	10	1.86
University of Belgrade	Serbia	1	10	1	10	1.86
KTH Royal Institute of Technology	Sweden	1	41	3	41	2.04
Universidade Federal de Viçosa	Brazil	1	10	1	10	1.86
Khalifa University of Science and Technology	United Arab Emirates	1	28	1	28	0.7
Latvia University of Life Sciences and Technologies	Latvia	1	10	1	10	1.86
Natural Resources Canada	Canada	1	17	3	17	4.22
University of Zadar	Croatia	1	6	3	6	0.6

Table 7. Cont.

Institution	Country/ Region	Scholarly Output	Citations	Authors	Citations per Publication	Field-Weighted Citation Impact
George Emil Palade University of Medicine, Pharmacy, Science and Technology of Targu Mures	Romania	1	10	1	10	1.86
Gorenje d.d	Slovenia	1	41	2	41	2.04
Industrija Nafta d.d.	Croatia	1	12	1	12	1.58
Universidad Maimónides	Argentina	1	10	1	10	1.86
University of Banja Luka	Bosnia and Herzegov- ina	1	12	1	12	1.58
International Hellenic University	Greece	1	10	1	10	1.86

* Source: Elsevier SciVal (January 2023).

Analysis of the top contributing researchers did not provide especially interesting results due to the very small size of the analyzed corpus of specialist literature.

2.3. Position of the Literature on Customer Communication and Education in Waste Management as Compared to the Global Research on Waste Management and Disposal

It is difficult to make any direct comparisons of a small and specialized body of literature that is characterized by a variety of different topics with the global field of extant research on the parent topic. Although a small body of knowledge of the Croatian and Slovenian waste management and disposal literature makes clustering very challenging, we conducted text mining of the literature titles and abstracts. The analysis and visualization were performed using the VOS Viewer tool produced by the University of Leiden CWTS research center.

Once again, it should be noted that the visualization results are very difficult to interpret due to the small number of items analyzed. However, the literature clusters, presented in Figure 4, show some recent researchers' interest in the topic of food waste as related to waste management and recycling practices in Croatia and Slovenia, which is further discussed.

Although the specialized corpus of Slovenian and Croatian literature on customer communication and education represents a tiny part of global waste management and disposal, its impact, as measured by the normalized number of citations and by the quality of publications outlets accepting such research, seems to be quite adequate and comparable to the global average in the parent field.

A single paper [35] with one contributing author affiliated with a Slovenian corporate research institution could be identified as directly discussing the potential interventions for greening the behavior of end customers. Therefore, it might be suggested that the potential for the direct application of the analyzed literature seems to be quite low. However, bibliometric analysis provides information about the researchers and research institutions who might serve as collaborating entities for policymakers, utility managers, and experts interested in promoting the pro-environmental behavior of citizens, i.e., end users of municipal utility companies' services. This especially applies to large public universities in Slovenia and Croatia, which seem to possess enough research capacity to engage in such applied topics.

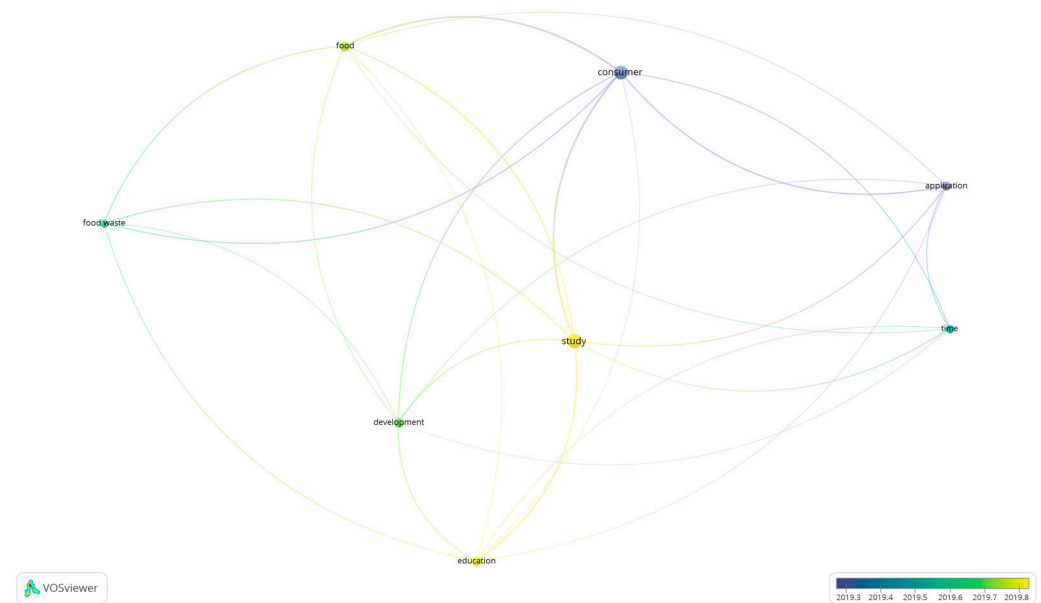


Figure 4. Keyword co-occurrence map (based on text mining of titles, abstracts and keywords of Slovenian and Croatian literature). **Source:** Authors.

2.4. Position of the Literature on Customer Communication and Education in Waste Management as Compared to Croatian and Slovenian Practices in Waste Management and Disposal

A manual review of the specialist literature, which is available as a Supporting Information file, was not able to identify multiple clusters that might be of interest to the practitioners in the waste management or recycling industries. There was one exception related to the research of food waste in households and the hospitality industry, which could be relevant for local authorities and companies who wish to influence consumer behavior patterns. In this context, it would be highly recommended for urban waste management stakeholders to engage in cooperation with local research institutions (see Table 7).

3. EU Institutional and Policy Context of Municipal Waste Management

Since the 1950s, an unprecedented increase in human activity has been observed in many areas. Global growth has led to a decline in natural resources. Currently, humanity is consuming the equivalent of 1.7 planets to provide the resources needed to produce goods and recycle waste. Therefore, the Earth needs 19 months to regenerate the resources used in a single year [36]. Moreover, by 2030, humanity will need 35% more food, 40% more water, and 50% more energy resources [37].

Efficient waste management can make a significant contribution to the efficient use of resources and, thereby, reduce environmental pollution. In European environmental policy, the key elements are managing waste in an environmentally friendly way and reusing the materials found in waste. Creating new products from such materials using the recycling process promotes the use of fewer raw materials and reduces the air pollution caused by burning waste and the pollution of water and soil created by dumping waste in landfills.

The EU waste policy aims to stimulate recycling, improve waste management, and limit landfilling through specific policies [38]. The European Environmental Agency assists European policy in this matter by providing knowledge and all needed information through reports. According to their recent report [39], there is a great potential to increase the amount of material collected for recycling in Europe—the amount of recycled municipal waste and electronic waste could double, and the amount of construction and demolition waste could be increased by 30%. The most significant obstacle to increasing the amount of recycled material is the low price of natural resources. In addition, processing mixed waste and waste with a complex composition is a real challenge. This should be assisted by the existing EU policy targets, which already set high standards, as they aim to take advantage

of the currently untapped recycling potential (e.g., the recycling targets for municipal waste until 2035).

Municipal waste represents around 10% of all waste generated in Europe [40]. Nevertheless, by reducing municipal waste or by increasing the proportion recycled, one could significantly contribute to reducing the negative impact on the environment. EU member countries can choose between four different methods of monitoring their progress. One of them is related to calculating the recycling rate as a proportion between the amount of material from recycled waste and the amount of the generated municipal waste. Furthermore, in 2015, the European Commission [38] proposed new targets: a recycling rate of 60% by 2025 and 65% by 2030. In addition, the European Commission proposed new targets for the reduction of municipal waste deposited in landfills and for packaging waste.

At optimum potential, the target of almost 80% of separate municipal waste collection could be reached. This is aligned with different policy instruments used in EU countries to increase the share of recycled waste. Statistics show that countries that use more instruments are more successful in increasing the share of recycled waste [38]. Simultaneously, even more important than the number of instruments is their effective implementation. Many countries use “pay-as-you-throw” schemes (i.e., fees based on the weight or volume of non-recycled waste). The implementation of this scheme, however, varies greatly between countries and even within a single country. Nevertheless, it turned out that countries with a recycling rate above 45% use the scheme in a similar way, while countries with a recycling rate below 20% do not use this scheme at all [38]. Furthermore, all countries that have a share of landfilled waste below the EU-28 average have either prohibited the disposal of biodegradable or mixed municipal waste in landfills or introduced a ban combined with a landfill tax of at least EUR 30 per ton [39]. Here, it should be emphasized that other factors also influence the recycling rate, such as environmental awareness and wealth (e.g., there is a correlation factor of 0.65 between the gross domestic product per person and the recycling rate), when the country started implementing measures to improve the waste management system.

4. Discussion of Practices in Recycling-Related Consumer Communication and Education in Slovenia and Croatia

In Slovenia, the Slopak company ensures the collection, sorting, processing, and recycling of residues of products on the domestic market. Slopak was established by a group of leading Slovenian companies in 2002 to ensure compliance with environmental obligations through mutual control, regardless of the market value of packaging. In addition to its leading role in the packaging waste management system in Slovenia, Slopak is also the leader in the field of waste management for plant protection products and used tires.

The company is dedicated to strengthening the system by communicating and educating Slovenian citizens, with the aim to change waste separation habits in Slovenia. Slopak ensures the fulfillment of all company obligations imposed by Slovenian legislation as related to the collection and recycling of the following materials:

- Product packaging;
- Electrical and electronic equipment;
- Batteries and accumulators;
- Medical waste;
- Used car and tractor tires;
- Plant protection products containing dangerous substances.

The new regulation [41] imposes an obligation on all companies distributing packed products on the Slovenian market to participate in a packaging waste management scheme. The obligation applies to all packaging (household and non-household), regardless of the type and quantity of the packaging material. The packaging must not contain more than 0.01% heavy metals and hazardous substances, e.g., lead, cadmium, mercury, and hexavalent chromium. Some exceptions are allowed for returnable and glass packaging. At

the end of each three-month period, companies distributing packaging or packaged goods on the Slovenian market have to pay an environmental tax on the basis of:

- Annual compensation for keeping records for the payment of environmental tax;
- Units of environmental load due to the generation of packaging waste per kilogram of packaging.

A company is eligible for a tax refund if it exports the packaging or packaged goods for which the duty has already been paid to another EU member state.

The ‘Green Dot label’ on packaging indicates that a financial contribution has been paid to a qualified national packaging recovery organization set up in accordance with the principles defined in European Packaging and Packaging Waste Directive 94/62 and the respective national law [42]. This internationally protected eco-label is used by more than 130,000 companies worldwide. In Slovenia, Slopak is the only authorized company to issue and regulate the use of the Green Dot label.

With the aim of redirecting waste from landfills to recycling, Slopak strives for comprehensive care for the environment, which includes a range of other services, including:

- Informing end users where waste is generated;
- Raising the awareness of the public through communication activities;
- Raising the awareness of children and young people about the importance of separate waste collection and recycling;
- Promoting new technologies and work processes in the industry.

Activities related to customer communication and education are a part of Slopak’s mission with the aim to contribute to proper waste separation and recycling. In 2019, Slopak participated in one of the most environmentally aware music festivals in Europe, ‘Metaldays’, with the campaign ‘Every can counts’, in cooperation with Ball Packaging Europe—Belgrade Ltd. At this event, special 3D letters were used to form the sign ‘Metaldays’, with each letter serving as a container for visitors’ used cans. Visitors were enthusiastic about collecting cans and filled all nine ‘letter containers’ during the festival. On the last day, with the support of Slopak’s team, the visitors squeezed the collected cans. In this way, they learned that it is necessary to empty and compress waste packaging before disposal, to take up as little space as possible, and that proper separate waste packaging helps achieve higher recycling rates.

Each year, Slopak, Pivovarna Laško Union, and the organizers of the ‘Beer and Flowers’ festival join forces to make the visitors of the festival camp aware of the manner and importance of the separate collection and recycling of cans. For example, in 2018, visitors to the camp were offered an opportunity to play the ‘Tic-Tac-Toe’ game with used cans, while in 2019, a can squeezing competition took place at the festival. Slopak also organizes a competition, named ‘Packaging is all around us’, for primary school students. Approximately, 135,000 children have participated to date, representing 40% of Slovenia’s young population. For high schools, Slopak organizes an awareness project ‘Eco Youth Parliament’.

In 2010, Slopak presented the ‘Eco Top Award’ for the most successful companies in reducing the amount of waste. In 2011, Slopak obtained funding from the European Commission under the financial mechanism of the Life program for the promotion of waste separation in Slovenia. By collaborating with researchers, utilities, schools, and various institutions, the project contributed to raising awareness in the field of waste separation.

In 2022, Slopak joined the sustainable initiative of the organizers of the Ski Jumping World Cup in Planica with the campaign ‘Every can counts’. In cooperation with the Faculty of Tourism Studies—Turistica, visitors were encouraged to collect used cans using special backpacks. This communicates the message that it is important to dispose of cans in the designated place as to ensure their onward path to recycling [43].

As early as 2005, Croatia introduced a new packaging recycling and recovery deposit system, in which a small amount (appx. HRK 0.5, i.e., EUR 0.07) is paid for each returned unit of qualifying empty packaging, such as a PET bottle, a metal can, etc. The fee is paid to the individuals returning the packaging to authorized collection points (usually located

in retail shops), which is financed by deposits (paid by consumers at the point of product purchase) and a system of environmental fees paid by the producers. The actual payments are usually made by the retail shops participating in the scheme, which are refunded by the Croatian Environmental Protection and Energy Efficiency Fund. Unlike in Slovenia, this Croatian public agency also collects waste management fees.

The regulation was extensive and complicated as it introduced national quotas and tied the producers' environmental fees to their achievement. The described system was not well received by packaging producers in Croatia and was described as less efficient and popular than the Slovenian alternative, i.e., the industry-owned Slopak company [44]. There was also a lack of a public campaign, except for the appearance of some government officials in the national media, resulting in misinformation to the public, e.g., some members of the public believed that only selected packaging materials were included in the scheme or only specially marked packaging was available for participation in the scheme. However, consumers received the new scheme well [44].

Despite deposit refund systems and their economics being complex [45], the described recycling scheme is still used in Croatia. It does not seem that it contributed significantly to national recycling performance, as in 2018, Croatia recycled only 15% of its municipal solid waste, incinerating approximately 3% and landfilling as much as 82% [46]. A recent paper does not mention any significant improvement in waste management benchmarks and mentions that significant public spending did not lead to complying with EU policy targets due to the inadequate legal framework, complex administration, and poor coordination of authorities at different levels [47].

5. Discussion

With targeted communication and education campaigns directed toward end customers, the amount of recycled packaging in mixed municipal waste could be reduced, producing both environmental benefits and reduced costs for product manufacturers. This approach would prove to be especially effective if associated with the usage of a deposit system for collecting packaging waste. However, the Croatian experience shows that such a system needs to be carefully managed because of its complex economy, and that intensive public communication is needed to frame public understanding of the deposit and waste collection systems in terms of encouraging pro-environmental behavior.

Unfortunately, this was not the case in Croatia where the media and public discourse often do not focus on the environmental aspects of the packaging deposit system. The payments made to the individuals handing in the recyclable packaging to the collection points are very small. However, they are often used by the socially deprived part of the population as a supplementary income. Public perception often revolves around the social implications of the system and focuses on social justice and activism issues. Such framing could lead to discussions away from environmental legislation (i.e., the promotion of pro-environmental behavior) and toward the discussion of national social policies and living standards, which has occurred in quite a few Croatian media outlets [44].

This could lead to the stigmatization of packaging recycling practices, as it is already perceived as an activity conducted by the urban poor, instead of being considered a form of socially responsible and pro-environmental behavior.

Critical implications for countries considering the introduction of packaging deposit and collection systems and other methods with which to encourage citizens to recycle municipal waste should concentrate on efforts for systematic promotion of pro-environmental behavior. In Croatia, based on case study research, a significant improvement in the social marketing capacity at the level of local communities and their governing structures was proposed to contribute to changes in citizen behavior [48]. The potential of such a social intervention at the community level was confirmed in the case of promoting pro-environmental behavior by McKenzie-Mohr [49].

Social marketing practices should not be limited to promotion only, but rather complemented with public relations and information on product packaging and the relevant

website(s). This was empirically confirmed in a survey of Croatian consumers' attitudes, which showed that respondents are ready to buy environmentally friendly products at higher prices [50]. In addition, the same study indicated a high acceptance of environmentally oriented marketing among Croatian consumers.

Similar implications can be derived from the available Slovenian research, which shows the positive attitudes of Slovenian consumers toward 'green products' [51]. Another study of attitudes toward 'green energy' in Slovenia found that younger and well educated individuals with a higher income were ready to pay more than the legally mandated charges [52]. This finding could be further extended to a more comprehensive intervention, aiming to change a wider set of customers' attitudes, including, e.g., how they respond to the perceived quality of everyday products, such as daily food supplies [53]. This could be important as food waste also attracted the attention of regional researchers in Slovenia and Croatia (see the previous discussion). Some practical examples of this interest are demonstrated in a recent Croatian public campaign focused on avoiding food waste among retailers and end consumers [54].

However, public campaigns and interventions related to raising environmental awareness among consumers willing to pay more for socially responsible practices need be reconsidered in the current economic and political landscape, which is characterized by high levels of inflation and increasing energy costs.

In Slovenia, the entire system of urban waste recycling has a higher level of acceptance by the companies involved in packaging recycling and recovery, with the industry-owned Slopak company positioned at the center of the system. Avoidance of public sector bureaucracy and regulation agency involvement creates a higher level of industry involvement and a commitment to the regular recycling processes and related innovative activities. One such innovation, which was mentioned in the literature [55], but is currently unexplored in Slovenia, relates to urban symbiosis, i.e., using urban waste as a source of materials and energy for industry. Additional cooperation between industry associations and local utility companies should be explored in Slovenia, with the Slopak company well positioned as a potential focal point for such partnerships. The described approach is consistent with the principles of stakeholder engagement and knowledge sharing, which were described as key drivers of sustainable urban waste management systems by Romano, Marciano, and Fiorelli [56].

Regardless of the limitations imposed by current events and the economic/political climate, the need for social marketing was identified as a vital implication for national and local governments, and municipal utility companies. Their relationships need to be directed toward the stakeholder partnership model, which serves as an excellent way to formulate solutions to waste management problems, including raising customers' environmental awareness [57]. Another implication, which is especially relevant for countries and regions with inefficient public bureaucracies and complex coordination among government levels, might be the introduction of Public-Private Partnerships (PPPs) in municipal waste management based on regulated market principles [58].

6. Concluding Remarks

This paper focuses on the urban waste management research and practices in Croatia and Slovenia, placing them in the European literature and EU policy contexts and identifying implications for the two countries. Special attention is paid to the education and communication with the municipal waste customers. These activities are contextualized by discussing the critical characteristics and implications of both the Slovenian system, which is based on the industry-owned Slopak company, and the Croatian system, which is based on the packaging recycling and recovery deposit system. In addition, we present various potential interventions that could improve waste recycling practices in both countries.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/recycling8030045/s1>, The list of analyzed Croatian and Slovenian literature, along with the full bibliometric details, is available as a Supplementary Material (in Excel format).

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