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Evolution of behavioral research on E-waste management: Conceptual frameworks and future research directions

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Abstract

The rapid growth of e-waste or waste electrical and electronic equipment (WEEE) has garnered significant attention from scholars, particularly in the behavioral domain. This study aims to conduct a comprehensive bibliometric analysis and content analysis to provide a systematic review of WEEE-behavioral research. Firstly, a bibliometric analysis was performed using Biblioshiny (R packages) on a sample of 293 articles from Scopus and WOS databases. This part addresses the research question: A) How has the WEEE-behavioral domain evolved over time in terms of key journals, institutions, countries, trending topics, and research streams? Secondly, a content analysis was conducted on 41 relevant articles that were able to address the following research questions: B) What are the main theories utilized and their implications in WEEE-behavioral research? and C) what are the potential directions for future research? The findings reveal two distinct research categories, namely circular economic behavior and behavioral spillovers, with seven underlying and emerging clusters followed by corresponding research streams. Additionally, the theory of planned behavior (TPB) emerged as the core theory that was extensively utilized and expanded upon. Consequently, this study contributes to 1) understanding the evolution of the WEEE-behavioral domain, 2) proposing an integrated theoretical framework, 3) identifying the primary research streams and their interconnections, and 4) suggesting avenues for future research, supported by a robust conceptual model for hypothesis generation.

KEYWORDS
content analysis, e-waste management, scientometric analysis, thematic mapping, theoretical framework, WEEE

1 | INTRODUCTION

The United Nations (UN) report reveals an annual generation of e-waste or waste electrical and electronic equipment (WEEE) exceeding a staggering 44 million metric tons, which is equivalent to an astounding 4,500 Eiffel Towers (Aboelmaged, 2021). Furthermore, projections indicate that this already alarming figure is expected to surge to a staggering 74.7 million tons by the year 2030 (Dhir, Malodia,

List of abbreviations: ABDC, Australian Business Deans Council; ABS, Chartered Association of Business Schools; A-B-C, Attitude-behavior-context theory; BRT, Behavioral reasoning theory; CB, Consumer behavior; CE, Circular economy; EEE, Electrical and electronic equipment; EOL, End-of-life; EPR, Extended producers responsibility; OSCM, Operations and supply chain management; OEM, Original equipment manufacturers; PBC, Perceived behavioral control; PEB, Pro-environmental behavior; RQ, Research question; TGC, Total global citations; TIB, Theory of interpersonal behavior; TLC, Total local citations; TPB, Theory of planned behavior; UN, United Nations; VT, Valence theory; WEEE, Waste electrical and electronic equipment; WOM, Word of mouth; WOS, Web of science; WTP, Willingness to pay; VBN, Value-belief-norm theory.

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et al., 2021). The annual growth rate of e-waste has surged at an alarming pace of approximately 45% (Dhir, Koshta, et al., 2021) establishing it as the unparalleled frontrunner in terms of the fastest-growing waste stream (Koshta et al., 2022). Thus, e-waste outpaces other solid wastes with a three-fold growth rate, presenting a formidable management challenge (Roy, 2016), particularly in developing economies.

Despite the measures, barely 20% of e-waste is processed via formal means or recycled through official mechanisms (Dhir, Malodia, et al., 2021), while the remaining 70%–80% is lost in the informal and illegal channels of which around 70% are dumped in Asian region (Orlins & Guan, 2016). Thus, e-waste emerges as a global problem raising numerous environmental, social, economic, and legal issues to solve. In this paradigm, the end-users act as the garrison for e-waste as they define its trajectory. Recently, end-users' impulsive buying behavior has resorted to extravagant use of devices to serve their fast and in-vogue life standards (Roy, 2016) leading to "product obsolescence" that conforms to significant sustainability challenges (Borthakur & Govind, 2018). In short, WEEE turns out to be a direct outcome of the skyrocketing obsolescence issue coupled with the "throw-away" mindset (Roy, 2016). Therefore, to improve "e-waste management", a better understanding of the behavioral paradigm is essential (Islam, Huda, et al., 2021).

Moreover, the design of the WEEE management system, policies, regulations, recycling interventions, country-specific behavior & culture, and availability of information, etc. constitutes a complex phenomenon (Islam, Huda, et al., 2021). This phenomenon has piqued the interest of scholars and, as a result, the literature on WEEE-behavioral research is proliferating (Islam, Huda, et al., 2021). Unfortunately, in spite of the enduring appeal to comprehend users' disposal behavior, there is a paucity that prevails in bringing about and integrating the literature on this ever-growing domain (Gilal et al., 2022).

A handful of contemporary literature reviews have concentrated on different facets of e-waste and consumer behavior (CB). These extant reviews cover topics such as relationships among CB constructs (Gilal et al., 2022), implications of CB on the CE (Islam, Huda, et al., 2021), conceptual frameworks for disposal behavior (Phulwani et al., 2021), meta-analysis of purchase intention of remanufactured products (Singhal et al., 2019) and, finally, testing new conceptual frameworks in an urban context (Borthakur & Govind, 2018). Interestingly, most of these studies focused on proposing conceptual models from CB perspectives. Hence, to distinguish and establish the significance of this review study, Table 1 illustrates the summary (or differences) of prior relevant review studies on e-waste management, which further enabled us to perform this systematic literature review based on the mixed method combining bibliometric and content analysis.

Amid these reviews, only Anandh et al. (2021) presented a bibliometric-based systematic review; however, their focus was only on the "WEEE reuse assessment" where one of the themes found was "WEEE-consumer behavior". Hence, motivated by this research gap, while employing a bibliometric approach, the first two research questions of this study are: (RQ1) What are the key journals, influential institutions, countries, and impactful and trending topics in the field of e-waste behavioral research?; and (RQ2) How has the WEEE-behavioral domain evolved over time and what are the underlying research streams?

The systematic review of Gilal et al. (2022) focused on finding out how the disposal behavior of consumers has been utilized in the literature and what theories, characteristics, and methodological approaches have been used to strengthen this behavior. However, their study only shows descriptive statistics rather than explaining them in detail via content analysis. Therefore, to fill the gap, this study ventures to explain, through a theoretical lens, the integrations and implications with a framework by following the research question (RQ3) What are the main theories used and their implications in WEEE-behavioral research? Finally, to pave the way for a future research avenue, the last research question posed is (RQ4) What are the possible directions for future research on the WEEE-behavioral domain in the field of business and management?

The current study also involves several contributions. The findings of RQ1 would help researchers in the e-waste management domain to recognize either collaboration or employment opportunities along with hot and blind spots while pinpointing the key outlets to publish their significant work. Findings of RQ2 and RQ3 would allow future scholars to gain an in-depth understanding of A) how the seminal theories are integrated and their implications with an integrated framework and B) how this field is evolving with a concrete research framework mapping WEEE-behavioral research streams, Finally, findings of RQ4 provide future research avenues that focus on a conceptual model to test for hypotheses with the seminal gaps.

2 | METHODOLOGY

2.1 | Bibliometric and content analysis methods

A plethora of quantitative and qualitative review methods exist. Following Bretas and Alon (2021), this study adopts a mixed method by combining both (a) bibliometric techniques (citation analysis, bibliographic coupling, keyword co-occurrence, thematic mapping, etc.) and (b) content analysis to investigate the research questions. The first phase of the study follows a quantitative approach via bibliometric techniques to extract, explain, and evaluate published studies. The goal is to use articulate, replicable search approaches and review techniques to improve the reliability of the results, while reducing the subjective biases of the literature review (Garfield, 1979; Maditati et al., 2018).

On the other hand, the second phase of the study is a content analysis that ideally illustrates the ongoing trends and directions of the literature, while pinpointing "blind spots" and "hot spots" (Gaur & Kumar, 2018). This helps to identify the most evolved (hot spots) and the least evolved research areas (blind spots) within the literature, which coupled with different bibliometric techniques, offer future avenues of research. Hence, in this study, the potential of the content analysis has been optimized by combining bibliometric methods (Bretas & Alon, 2021).

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TABLE 1 Summary of prior review works.

Author	Behavioral type	Research question	Scope	Method	Articles reviewed	Time frame	ABS-rank	Database	Theoretical integration
Gilal et al. (2022)	Disposal	• How disposal behavior has been utilized as a construct in the literature and what theories, contexts, characteristics, and methodological approaches have been used to strengthen this behavior? • What are the key research gaps and future agendas?	Summarizing the relationships among constructs from the consumer behavior perspective.	Qualitative (systematic literature review)	43	2000 to 2021	2	Scopus	No
Islam, Huda, et al. (2021)	Consumer-centric circular economy	• How do issues related to consumer awareness & behavior, which have a particular focus on the e-waste sector, contribute to the essential operational framework in achieving a CE? • How the understanding contributes to informing policymakers and researchers in identifying future policy measures and the necessity of performing research studies in the area?	Consumer behavior and its implication on the circular economy.	Qualitative (content analysis-based review)	109	2005 to 2020	2	WoS	No
Phulwani et al. (2021)	Disposal (personal communication devices)	• What are the factors affecting disposal of personal communication devices? • How an integrated conceptual model can explain environmentally responsible consumer behavior using the theory of planned behavior (TPB)?	A conceptual framework for consumer disposal behavior.	Qualitative (structured literature review)	87	2005 to 2019	2	Scopus	No
Singhal et al. (2019)	Remanufacturing	• How to prioritize the critical factors that influence the purchase intent of the consumers towards remanufactured products? • Which types of product are consumers more conscious of regarding the environment?	Statistically synthesizes and analyzes the factors relevant to the purchase intention of the remanufactured products	Quantitative (meta-analysis)	10	2011 to 2018	3	Science direct, ProQuest, Scopus, EBSCO	No

(Continues)

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TABLE 1 (Continued)

Author	Behavioral type	Research question	Scope	Method	Articles reviewed	Time frame	ABS-rank	Database	Theoretical integration
Borthakur and Govind (2018)	Consumption & Disposal (households' electronics)	• Based on the "public's perceptions" what are the determinants of e-waste disposal behavior in India?	Testing a new conceptual framework in the Indian context.	Qualitative (literature review)	67	2005 to 2016	2	WoS & Scopus	No
This study	End users' behavior: (recycle, reuse, return, remanufacture, CE, collection, consumption & disposal)	• What are the key journals, influential institutions, countries, authors, impactful and trending articles, and topics in the field of "e-waste behavioral research"? • What are the main theories used and their implications & integration in operations research? (framework) • How have the WEEE-behavioral research domains evolved over time and what are the underlying research streams? (framework) • What are the possible directions for future research on WEEE-behavioral research in business and management?	A comprehensive review of the literature employing a mixed method by both quantifying (bibliometric) and qualifying (content analysis) the WEEE-behavioral studies from in-depth theory while proposing multiple conceptual frameworks to fill future research gaps.	Quantitative & Qualitative: Bibliometric →content analysis	Bibliometric: 293 Content analysis: 41	Content analysis: 2009 to 2022; bibliometric: 1996 to 2022	NA	WoS & Scopus	Yes

Abbreviations: CE, circular economy; TPB, theory of planned behavior; WEEE, waste electrical and electronic equipment.

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The Bibliometrix package in the R-studio has been used here for visualization and data analysis. Using the Biblioshiny package in R, a set of performance citation analyses has been performed on the most relevant authors, journals, countries, topics, and institutions in the field of WEEE-behavioral research. Later, using the Bibliometrix package in R with the Louvain clustering algorithm along with association normalization, "bibliographic coupling" has been conducted to present the intellectual structure and show how the domain is evolving. The bibliographic coupling technique examines the likeness between two articles using the number of shared references (Elango, 2019; Sanchez-Famoso et al., 2020). For further graphical visualization of the R packages' graphlayouts, ggraph, and Kamada–Kawai layout were executed.

Using the co-occurrence network of the author keywords, the thematic structure of the research area was explored (Bretas & Alon, 2021). Furthermore, in order to create a conceptual thematic map, the Bibliometrix R-package (Biblioshiny) has been used to illustrate the research streams and their positions from the viewpoint of a "centrality and density map" (Zupic & Čater, 2015). Finally, the content analysis was done to enhance the understanding of the conceptual and intellectual patterns that materialized utilizing prior techniques (Gaur & Kumar, 2018), which eventually helped to identify the literature's theoretical lenses and trends and suggest avenues for future research (Alon et al., 2018).

2.2 | Data extraction and article selection

This review is based upon the extraction and compilation of bibliographic data from both Web of Science (WoS) and Scopus databases, the two most acknowledged bibliographic databases (Aria & Cuccurullo, 2017). With over 22,000 titles and 87 million records covering 240 disciplines and 7,000 publishers, Scopus is the most extensive interdisciplinary abstract and citation database (Rejeb et al., 2022). Thus, Scopus has been the primary choice because of the comprehensive range of its peer-reviewed literature. On the other hand, although the Web of Science database has narrower coverage compared with Scopus, it has also been utilized here to cover seminal articles that are not Scopus-indexed. Thereby, these two seminal databases complement each other by maximizing the identification of relevant studies (Rejeb et al., 2022).

Brocke et al. (2009) emphasized the significance of the literature search strategy for review articles. Hence, this study has adopted the literature search approach from the seminal bibliometric analysis of Bretas and Alon (2021) and (Rejeb et al., 2022). Thus, to extract the sample, a step-by-step approach has been employed (see Figure 1).

A comprehensive Boolean search was performed on WEEE-behavioral research using a combination of the keywords: (a) Electronic Waste = ("e-waste" OR "e-waste electrical and electronics" OR "e-waste management" OR "WEEE" OR "Waste Electrical and Electronic Equipment" OR "electronic scrap" OR "obsolete electronics" OR "waste electronics" OR "electronic waste" OR "electrical waste" OR "waste electrical" OR "electronic rubbish" OR "electronic garbage" OR "end-of-life items") AND (b) Behavioral terms = "consumer e-waste disposal behavior" OR "behavior" OR "intent" OR "intention" OR "consumer" OR "customer" OR "household" OR "resident" OR "public" OR "dispose" OR "disposal" OR "discard" OR "discarding" AND "survey" from both Scopus and WoS databases. The search protocol was limited to topics that cover titles, abstracts, and keywords (Rejeb et al., 2022). The full search query can be found in Appendix 1.

The search protocol considered only articles published with the "final" status (pubstage = Final) prior to 25th December 2022. Originally, the search query delivered 6,563 documents from WoS and Scopus. As shown in Figure 1, different selection criteria were employed to pinpoint the articles that should either be screened out (exclusion criteria) or be considered (inclusion criteria) (Tranfield et al., 2003). For example, to ensure quality, only articles published in both ABS (Chartered Association of Business Schools) and ABDC (Australian Business Deans Council) indexed journals were considered. Both indexes show journal ratings reminiscent of the outcomes sanctioned by the subject experts of the Scientific Committee with expert peers and scholarly associations, where the aim is to include a broad collection of journals in the field of business and management. The language was limited to English. Furthermore, conferences, book chapters, books, trade journals, reviews, and research notes were excluded. Hence, in the final stage, only original journal articles in the English language were selected. These refinements resulted in a total of 4,357 articles.

At the initial phases, it is not uncommon to have a bigger pool of results (Bakker, 2010). However, this still hinders an in-depth textual analysis. Therefore, this study has systematically lowered the large number of articles by restricting the subject area to business economics, operations research management, and business & management in order to evade the disparities in research outputs, thus guaranteeing a more detailed breakdown of this area while stimulating adequate generalizability (Rejeb et al., 2022). Thus, this refinement reduced the total number of articles to 340 (Scopus = 229, Web of Science = 111), which were later screened for redundancy. For these 340 articles, the authors separately extracted the bibliometric data from Scopus (229) and WoS (111). Henceforth, duplicated documents were taken out using the R-studio application. The screening led to the selection of 293 publications for further review.

Finally, after extracting the final sample of 293 articles for the bibliometric analysis, the full text of each article was closely scrutinized by two authors to validate them according to the goals of this study. At this phase, a set of 41 relevant articles was retained for the content analysis. This approach helped to determine the leading research categories and streams, trends, and recommendations for future studies (Bretas & Alon, 2021). The first author conducted a thorough reading and review of the articles and coded them in NVivo software, which retained the main insights of the articles as: country, methodology, key theoretical implications, key findings, main hypotheses, research question, gaps fulfilled, and future scope of research.

3 | BIBLIOMETRIC ANALYSIS

Multiple techniques, namely co-citation analysis, citation analysis, and bibliometric coupling, are usually employed for bibliometric analysis.

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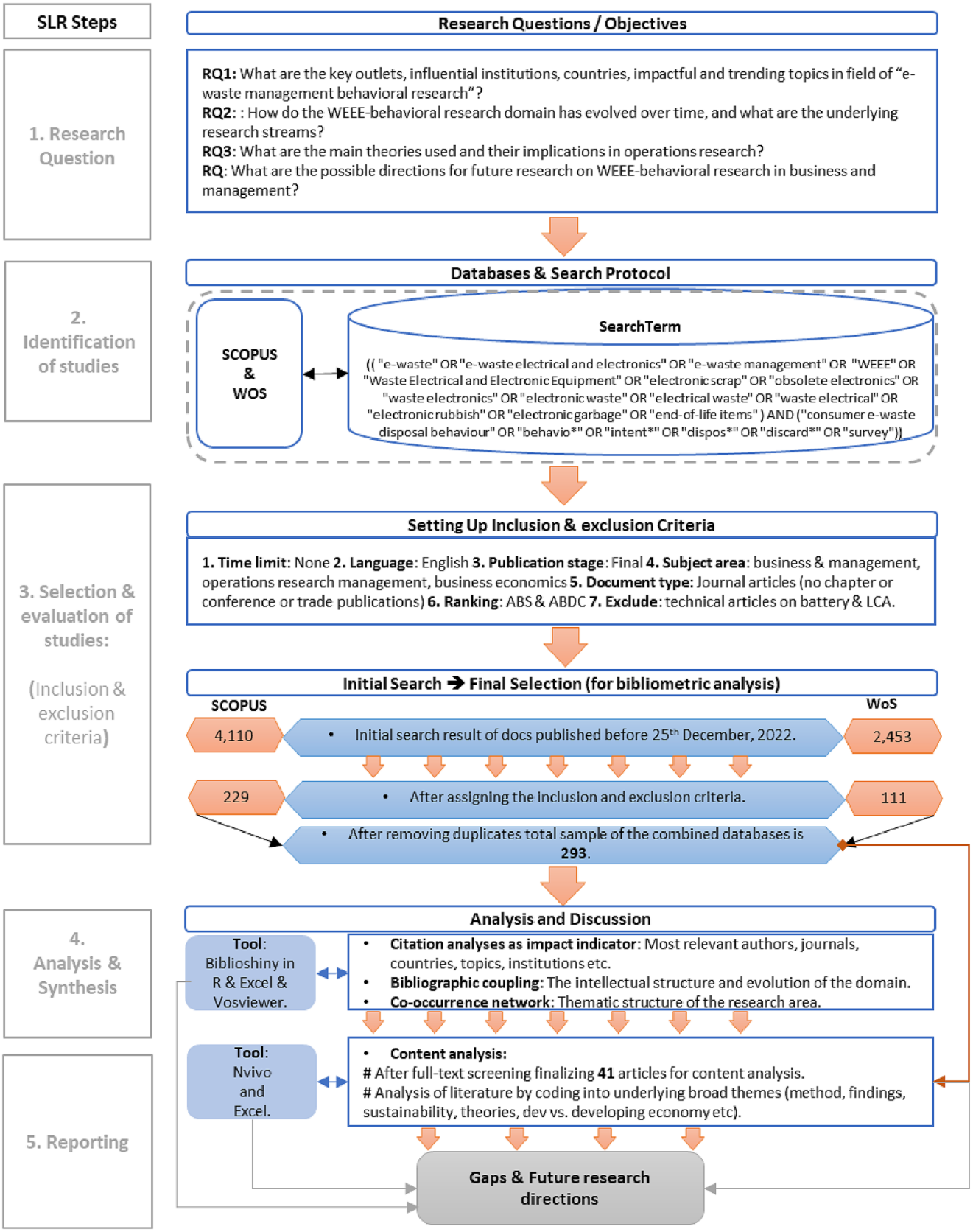

FIGURE 1 Methodological flowchart for bibliometric and content analysis review.

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However, the selection of the technique relies upon the objective of the investigation (Bretas & Alon, 2021). Considering the research questions, citation analyses have been performed to reveal the most relevant institutes, top authors, articles, and journals. Meanwhile, bibliographic coupling helped to recognize the structure or interconnections of the literature as it is more suitable for pinpointing new articles yet to receive citations, niche subfields, and emerging domains (Zupic & Čater, 2015). Also, the conceptual structure of the WEEE-behavioral domain was verified via keyword co-occurrence and a conceptual thematic map.

3.1 | Preliminary data statistics

In total, 898 authors had written 293 articles (the final sample) that were published in 119 journals with 28.96 citations per article. The first published article in the dataset was in 1996. The growth rate (annual) of published studies in the WEEE-behavioral sector is 14.26% (see Figure 2). Until 2011, the highest number of yearly publications was very low (below seven articles) and by this time (over 16 years) only 32 studies were published. However, from 2016 to December 2022 it spiked to 208, depicting 73.5% of the total sample. Also, the citations started to hit double digits after 2012 and kept soaring. The year 2021 saw the highest number of citations. Therefore, the growth graph in Figure 2 illustrates the growing interest in and relevance of WEEE-behavioral studies in recent times.

3.2 | Most relevant articles, institutions, journals, and authors

This section presents citation analyses to point out the most relevant and impactful articles, institutions, journals, and authors. Table 2 below summarizes the leading 10 journals that published WEEE-behavioral studies. As this is a transdisciplinary topic, the journals also represent diverse academic areas such as business and management, operations management, environmental science, sustainability, economics, waste management, engineering, decision science, etc. Out of 119 journals, the Journal of Cleaner Production itself has the biggest share with 115 articles and 4,700 citations. The dispersion is extremely wide and there are only three other journals that published more than five articles on this emerging field: International Journal of Production Economics (nine articles), International Journal of Production Research (six articles), and Business Strategy and The Environment (six articles). The same ranking applies to these four journals in terms of impact (h-index) assessment.

To examine the impacts of the journals further, they were split into four quadrants (see Figure 3): (A) high focus on WEEE-behavioral research and high impact; (B) low focus on WEEE-behavioral research but high impact; (C) low focus on WEEE-behavioral research and low impact; finally, (D) high focus on WEEE-behavioral research but low impact. For the sake of better visualization, only the best 10 journals (sorted by TC/t or avg. citation) were taken for the quadrant mapping.

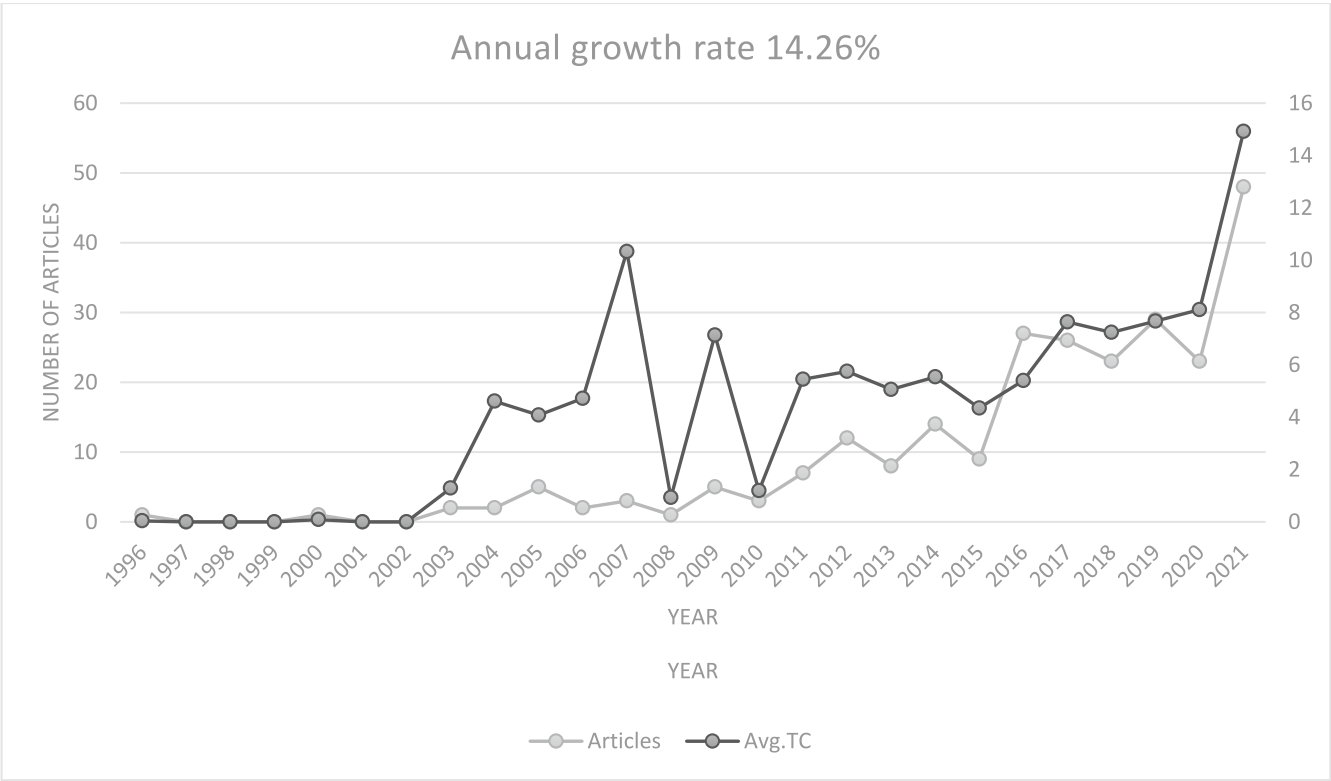

FIGURE 2 Annual growth of scientific production.

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TABLE 2 Top 10 most productive and impactful journals.

Rank	Journal (sorted by publication)	Publications	h_index	TC
1	Journal of Cleaner Production	115	41	4,700
2	International Journal of Production Economics	9	7	568
3	International Journal of Production Research	6	5	147
4	Business Strategy and the Environment	6	4	68
5	European Journal of Operational Research	5	5	334
6	Production and Operations Management	4	4	339
7	International Environmental Agreements-Politics, Law and Economics	4	2	23
8	Management and Labour Studies	4	1	3
9	International Journal of Logistics Systems and Management	3	3	44
10	Technological Forecasting and Social Change	3	3	145

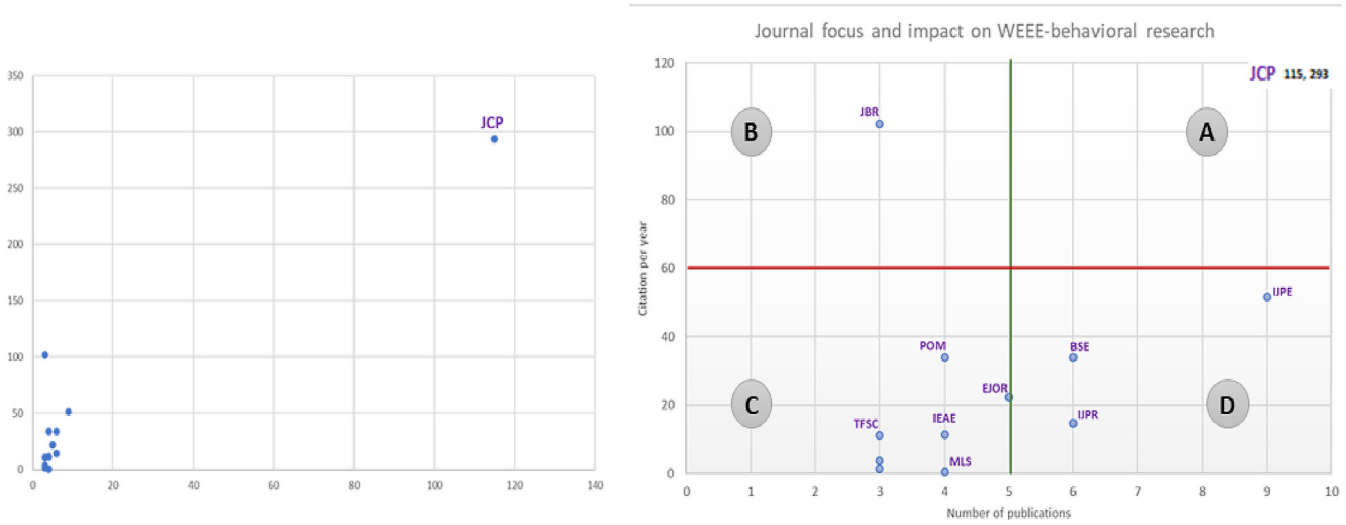

FIGURE 3 Journal impact & focus by 2 X 2 matrix.

To make the quadrants, "focus" was represented by "number of articles published" and "impact" was represented by "TC/t or the avg. citation". Figure 3 presents a 2 × 2 matrix, where the average citations were plotted on the Y-axis, while the number of articles per journal was plotted on the Y-axis. The green line in parallel with the Y-axis is the average number of articles, while the red line in parallel with the X-axis is the average citation.

Among these 10 journals, only the Journal of Cleaner Production belongs to quadrant A, with the highest number of publications and citations. The Journal of Business Research is the only journal in quadrant B with higher-than-average citations but fewer publications. For five of the journals (POM, EJOR, TFSC, IEAE, and MLS), Quadrant C has the most density of journals with low impact and low focus on the WEEE-behavioral domain. Finally, quadrant D has only three journals (BSE, IJPE, and IJPR) showing higher focus but low impact. For more detail, journals in the quadrants are labeled in the right half of Figure 3.

The top 15 relevant studies in the domain of e-waste and behavior are presented in Table 3. The impact of these articles is illustrated by both total global citations (TGC) and total local citations (TLC). As per the TGC/t, Wang et al. (2016) turn out to be the most influential; however, following the TLC/t, the study of Wang et al. (2011) is the most significant. Most of the influential studies are from the Chinese context focusing on different behaviors and intentions (e.g., recycling, collection, reuse, disposal, etc.).

Concerning the number of contributions, the top three institutions researching e-waste and behavioral aspects are all from China: Tsinghua University (25 articles); China University of Mining and Technology (18 articles); and Beijing University of Technology (12 articles). Of the top 20 influential institutes, 70% are Chinese. From the list of top 20 institutes, 16 are from developing and emerging countries, while from the developed world only Swedish (eight articles), Italian (seven articles), and Austrian (six articles) institutes are at the forefront (see Table 4). Therefore, it seems that behavioral research in

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TABLE 3 Top 15 most relevant articles.

Rank	Author-year (sorted by TLC/t)	TGC	TGC/t	TLC	TLC/t
1	Wang et al. (2011)	204	17	19	1.58
2	Wang et al. (2016)	136	19.43	11	1.57
3	Chi et al. (2014)	134	14.89	10	1.11
4	Nnorom et al. (2009)	117	8.357	11	0.79
5	Zeng et al. (2015)	94	11.75	5	0.63
6	Plambeck and Wang (2009)	156	11.14	7	0.50
7	Atasu and Van Wassenhove (2012)	107	9.727	5	0.45
8	Afroz et al. (2013)	148	14.8	4	0.40
9	Parajuly and Wenzel (2017)	93	15.5	2	0.33
10	Nagurney and Toyasaki (2005)	240	13.33	5	0.28
11	Rahman and Subramanian (2012)	182	16.55	3	0.27
12	Huang et al. (2006)	98	5.765	4	0.24
13	Atasu et al. (2013)	90	9	2	0.20
14	Hammond and Beullens (2007)	189	11.81	3	0.19
15	Jacobs and Subramanian (2012)	134	12.18	2	0.18

Abbreviations: TGC = Total global citations; TGC/t = Average global citations per year; TLC = Total local citations; TLC/t = Average local citations per year.

TABLE 4 Top 20 institutes.

Rank	Affiliation (sorted by publication)	Publications	Country
1	Tsinghua University	25	China
2	China University of Mining and Technology	18	China
3	Beijing University of Technology	12	China
4	Beijing Institute of Technology (School of Management and Economics)	11	China
5	Shandong University of Science and Technology	11	China
6	Shanghai Polytechnic University	9	China
7	Shanghai University	9	China
8	Shenzhen University	9	China
9	University of São Paulo	9	Brazil
10	University of Science and Technology Beijing	9	China
11	Chalmers University of Technology	8	Sweden
12	Shandong University	8	China
13	Zhejiang University of Technology	8	China
14	East China University of Science and Technology	7	China
15	Huazhong University of Science and Technology	7	China
16	Monash University Malaysia	7	Malaysia
17	Politecnico Di Milano	7	Italy
18	Federal University of Itajuba (Unifei)	6	Brazil
19	Shanghai Jiao Tong University	6	China
20	Vienna University of Technology	6	Austria

WEEE has been dominated by developing economies. The country with the most notable scientific production is China (83 articles), followed by India (51 articles), the USA (43 articles), Brazil (19 articles), Malaysia & UK (14 articles), and Germany & Italy (12 articles each) (see Figure 4). The most cited countries are, again, China (2,436 citations), followed by the United States (1536), the United Kingdom (605), India (455), Brazil (454), Malaysia (430), Germany (265), and Australia (430). These findings also hold that major contributions are coming from institutions in emerging countries, although the USA and UK also have significant contributions in terms of impact or citation.

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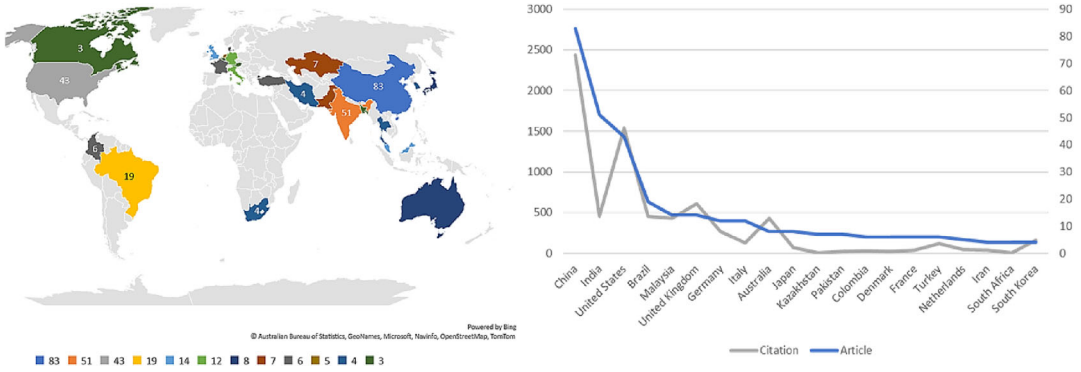

FIGURE 4 Country map.

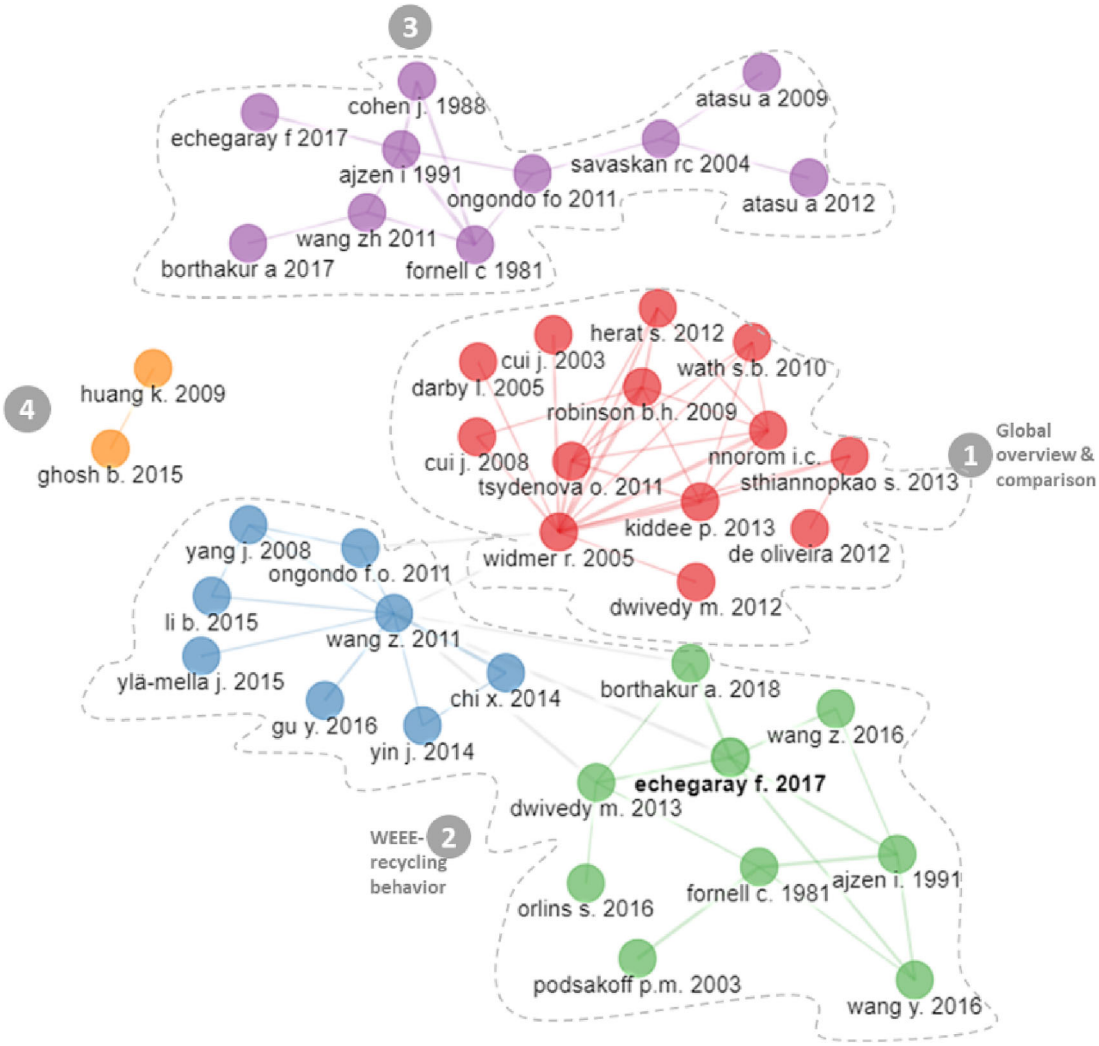

FIGURE 5 Bibliographic coupling showing linkages across articles.

3.3 | Bibliographic coupling

Figure 5 portrays the network of bibliographic couplings in the domain of behavioral research within e-waste. The nodes symbolize the documents and the edges represent bibliographic couplings. There are four clusters that we labeled numerically (see Figure 5). There are two main dominating clusters that are also interconnected. Based on the bibliographic coupling networks and an analysis of the articles' content in each cluster, the major research categories were identified.

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The first cluster (Number 1) is labeled as "global overview and comparison". The studies in the cluster are split into two main research categories. The first one focuses on the review articles illustrating the overview, production, environmental impacts, management practices, and legislations on e-waste management from a global perspective. Some examples include global overviews of the toxic impact on health and the environment and corresponding strategies and practices (Kiddee et al., 2013; Nnorom & Osibanjo, 2008; Robinson, 2009; Widmer et al., 2005). The second research category focuses on the issues and practices in developing economies. For instance, challenges in the Asian region (Herat & Agamuthu, 2012), comparison between different economies (Oliveira et al., 2012; Sthiannopkao & Wong, 2013), and sustainability issues in emerging regions (Dwivedy & Mittal, 2012; Wath et al., 2010), while the study of Darby and Obara (2005) focuses on recycling and disposal behavior of households from a developed economy perspective.

The second cluster (Number 2) is named "WEEE-recycling behavior". The studies in this cluster concentrate on different factors of household and CB in terms of e-waste recycling, using the theory of planned behavior (TPB). These studies are heavily focused on developing economic contexts (China, India, and Brazil). Some examples include behaviors such as willingness to recycle (Dwivedy & Mittal, 2013; Wang et al., 2011); determinants of consumer recycling intentions (Echegaray & Hansstein, 2017), attitudes and willingness to pay (WTP; Yin et al., 2014), awareness and perceptions (Ylä-Mella et al., 2015); collection channels of WEEE and household recycling behaviors (Chi et al., 2014); knowledge & perception of remanufactured products (Wang & Hazen, 2016); perceptions of informal recycling (Wang et al., 2016); and public understanding of WEEE (Borthakur & Govind, 2018). In this cluster, the study of Ylä-Mella et al. (2015) is the only one from the developed (Finland) world. The last significant cluster (Number 3) shows several behavioral studies like cluster 2; for instance, the determinants of consumer recycling intentions (Echegaray & Hansstein, 2017) and residents' willingness to recycle (Wang et al., 2011). Furthermore, it points out the study of Fornell and Larcker (1981) and Cohen (1988) that hint toward structural equation modeling as the methodology for behavioral studies in this domain. Furthermore, this cluster also illustrates the take-back legislation topic (Atasu et al., 2009; Atasu & Van Wassenhove, 2012).

3.4 | Temporal evolution of themes

Figure 6 demonstrates the temporal transition of themes using the keywords over three timelines (1996–2004, 2005–2013, and 2013–2021) representing the most frequent and looming themes (Bretas & Alon, 2021).

Between 1996 and 2004, themes related to WEEE "regulation" and its "environmental impact" emerged; hence, there is no substantial scholarly attention. During the period 2005–2013, several themes such as "environmental regulation", "sustainable development", "supply chain & reverse logistics", "EOL product", and "management" started to evolve with an acute focus on China. Later, from 2013 to 2021, these scattered themes began to converge and ripen into four main major generic themes, namely "e-waste or WEEE or e-waste management", "waste disposal", "management", and "reverse logistics". The realm of e-waste management research truly matured in this time frame. However, the new branch of behavioral research in WEEE

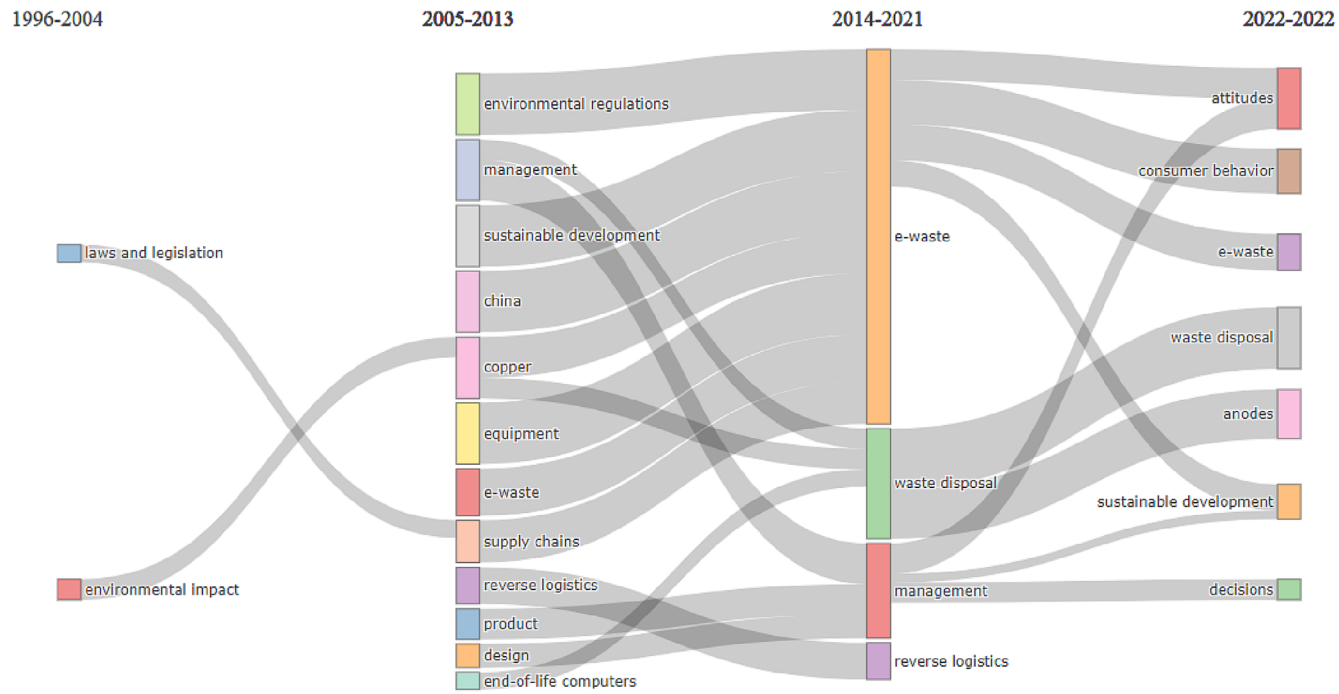

FIGURE 6 Temporal evolution of keywords.

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has only been triggered to evolve with continuous prominence in the past 2 years (2021–2022). Behavioral niche themes, such as "attitude", "consumer behavior", "anodes", "purchase decision", and "intentions" with a specific focus on "sustainable development" or sustainability, have just started to materialize in this paradigm.

3.5 | Conceptual thematic map

Figure 7 illustrates the centrality-density thematic map by plotting the relevant topics that were determined via authors' keywords on a two-dimensional thematic map. The thematic map exhibits the strength of their external (centrality) and internal (density) relationships. It has four quadrants: topics with low density and low centrality (type 1), high density and high centrality (type 2), low density and high centrality (type 3), and high density and low centrality (type 4) (Bretas & Alon, 2021).

The topics in the type 2 quadrant have a high level of internal and external connections, thus are regarded as mainstream or motor themes. Topics related to CB, recycling, metal recovery, and supply chains are located in this quadrant. The focus is on recycling behavior and recovery in the supply chains using primary data (e.g., surveys). However, the topics in quadrant type 1, with low density and centrality, are inadequately formed or emerging themes with the potential to expand further. The main themes here are the antecedents of recycling & disposal behavior, waste management, and product design. It is understandable since research regarding how product design and management of disposal systems can impact behavior (emerging economies) lacks academic attention in this domain. In quadrant type 3, with low density and high centrality, the topics are basic and transversal. Hence, this cluster presents the general topics related to WEEE behavior such as knowledge and motivation. The last quadrant (type 4), with high density and low centrality, presents studies about specialized or niche themes such as attitudes, intention, and information.

4 | CONTENT ANALYSIS AND DISCUSSION

Content analysis helps to specify and document fairly the objective features of research that make the results more plausible when more than one researcher is engaged (Maditati et al., 2018). Thus, a systematic review of the contents of these 41 articles was performed by two researchers to answer the corresponding research questions (RQ2, RQ3, and RQ4). Appendix 2 illustrates detailed information (category and streams) about the 41 articles identified based on the content analysis. The major clusters are divided into different categories and research streams, types of study, methods, and context used.

4.1 | Research categories and streams

Based on the content analysis of these 41 seminal studies, two clusters, namely A) CE behavior and B) behavioral spillover, were created. The CE behavior is composed of the 5Rs or recycling, remanufacturing, return, repair, and replacement related behaviors; while the behavioral spillover consists of categories such as public understanding, sustainable CB, and law & regulation. Figure 8 presents the resulting research framework combining the clusters and corresponding categories and research streams.

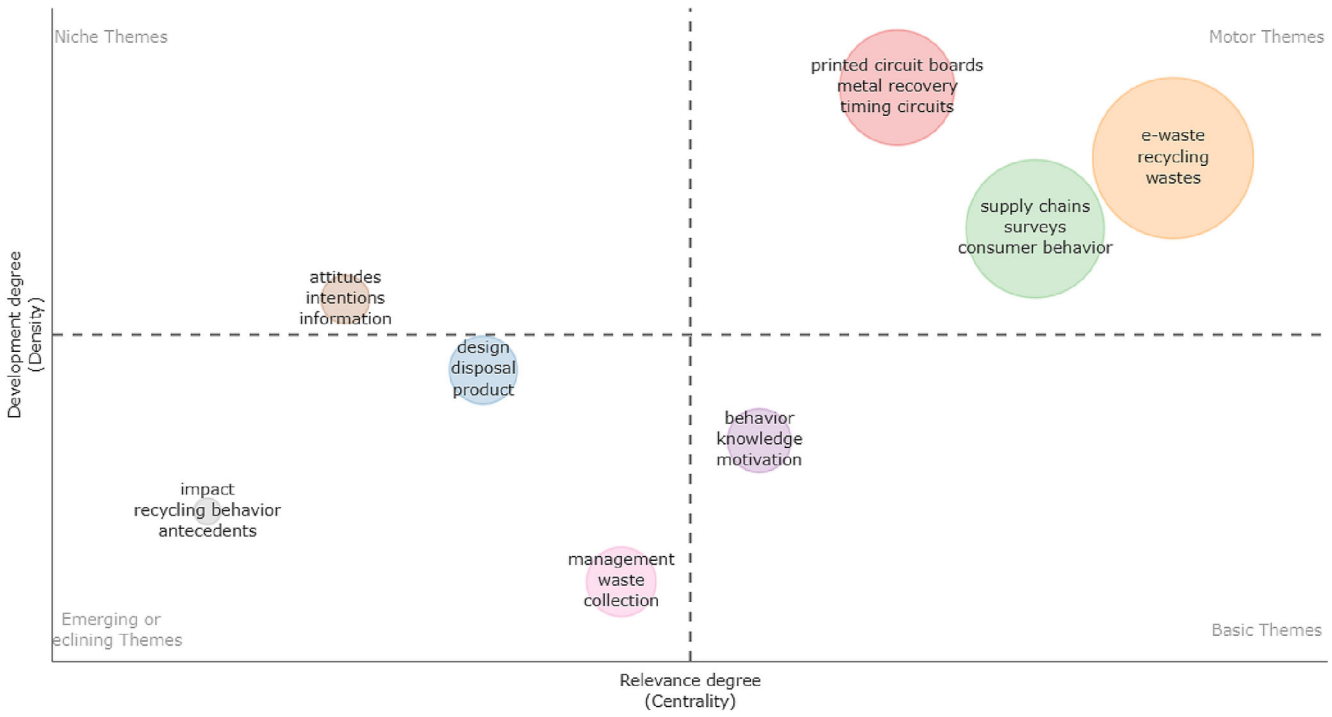

FIGURE 7 Conceptual thematic map.

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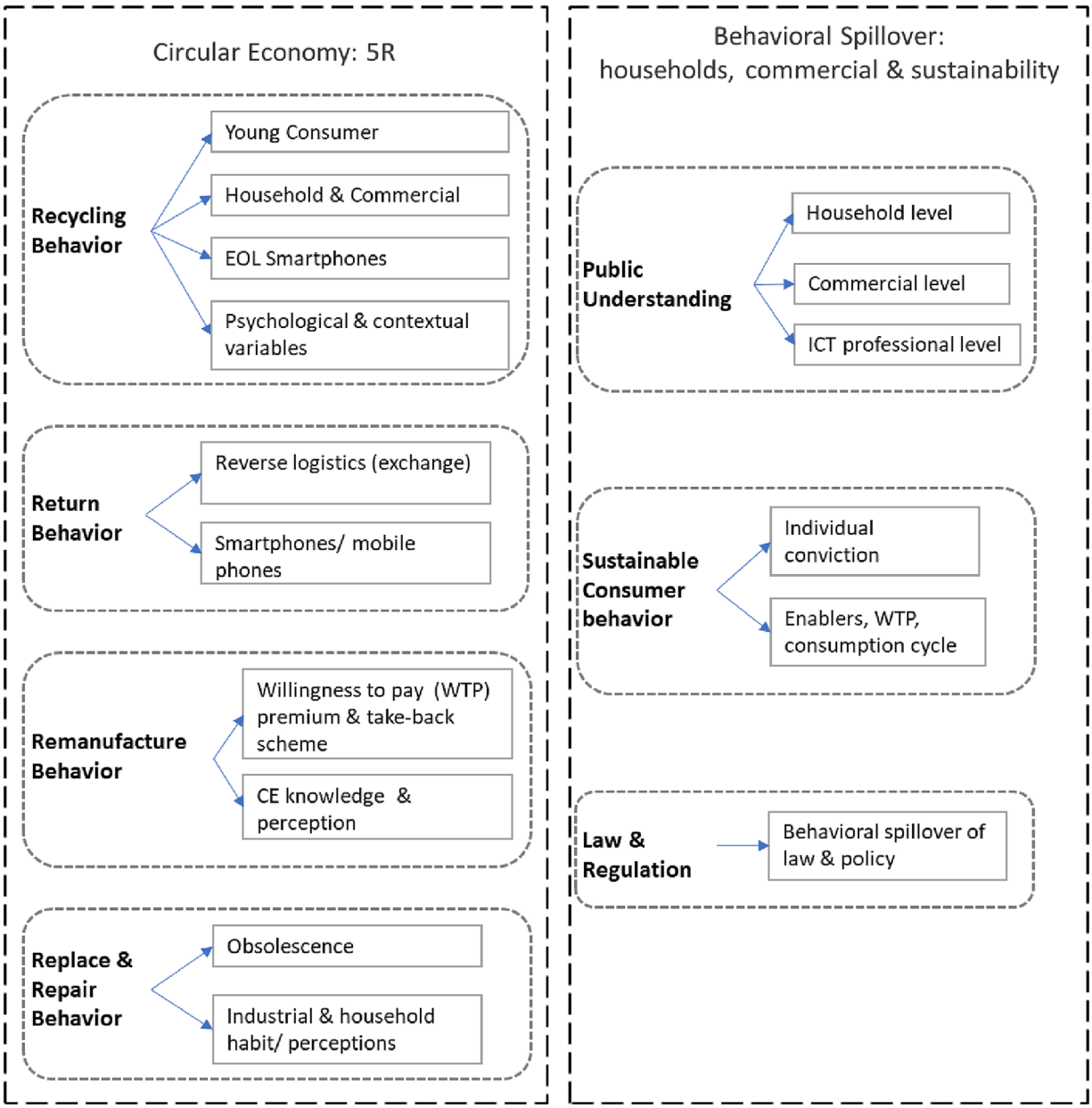

FIGURE 8 WEE behavioral research framework.

4.1.1 | CE behavior

Recycling behavior

Most of the behavioral research has been done on e-waste recycling. Behaviors related to young consumers (Aboelmaged, 2021; Islam, Dias, & Huda, 2021), households (Chi et al., 2014; Dhir, Koshta, et al., 2021; Dhir, Malodia, et al., 2021; Koshta et al., 2022; Otto et al., 2018; Wang et al., 2016), and EOL mobile phones (Bai et al., 2018; Najmi et al., 2021; Nnorom et al., 2009) are the main streams that mostly used psychological and contextual variables by integrating and extending the TPB (Aboelmaged, 2021; Echegaray & Hansstein, 2017; Koshta et al., 2022; Najmi et al., 2021; Roy, 2016; Zhang et al., 2019) with other theories.

Young consumers' behavior has been studied for both developed and developing regions. In both regions, the "lack of knowledge" of the existent recycling or treatment program is mentioned as a key factor for their behavior not being reflected in practice. Thus, a proper awareness program is a must-have to correct the WEEE disposal behavior. Hoarding WEEE at home and not using proper channels is common practice among the youth, which is enhanced by the low price of new gadgets and product obsolescence due to fast updates. In terms of psychological factors, attitude and habits act as important enablers to recycling; however, the effect of behavioral control and subjective norms did not result in significant support for the recycling intention.

Currently, because of the miniaturization effect and faster obsolescence, smartphones have become a major contributor to e-waste.

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Moral norms and attitude were found to be important, while behavioral control was the least significant factor behind mobile phone recycling behavior. In some developing contexts, people have the knowledge, but are not very willing to recycle. The main reason is information security followed by convenience and incentive, which results in more storage at home and eventually a failed recycling system. Therefore, gaining people's trust by safeguarding their personal information would help to build a successful smartphone recycling system. Also, when it comes to "WTP premium" for green phones, the younger and higher-income groups with environmental awareness are more prone to step up.

Most of the recycling studies focusing on households' behavior had assessed the associations between different contextual and psychological variables from seminal theories such as the TPB, behavioral reasoning theory (BRT), Valence Theory, etc. The most common factors that were tested against the intention to recycle were WTP (Koshta et al., 2022; Nnorom et al., 2009), attitude (Dhir, Koshta, et al., 2021; Echegaray & Hansstein, 2017; Wang et al., 2016; Zhang et al., 2019), subjective norms (Echegaray & Hansstein, 2017; Koshta et al., 2022; Zhang et al., 2019), environmental awareness and concerns (Dhir, Koshta, et al., 2021; Dhir, Malodia, et al., 2021; Wang et al., 2016), convenience or comfort (Otto et al., 2018; Wang et al., 2016; Zhang et al., 2019), and behavioral control (PBC) (Echegaray & Hansstein, 2017; Koshta et al., 2022). Also, different demographic variables were tested against intention too (Dhir, Malodia, et al., 2021; Echegaray & Hansstein, 2017). Apart from the most common factors, other variables, such as perceived benefits, perceived social acceptance, behavioral costs, perceptions of informal recycling (mediating role), and disposal subsidy (moderating role), were also found to have significant effects on shaping recycling behavior.

Replacement and repair behavior

Replacement and repair behaviors are important, yet less, explored topics, which are also interconnected. The most typical repair practice is replacement since unprofessional individuals are not able to repair complicated parts (Raihanian Mashhadi et al., 2016). Also, people usually do not opt for repair because of component repair costs, knowledge about repair shops, and inconvenience of transport, which altogether influences their decision-making process. For industrial products (e.g., solar panels) due to the steep drop in cost and enhanced efficiency, "premature replacement" is taking place, while small electrical and electronic equipment (EEE) are replaced because of break down and lack of accessories (Pérez-Belis et al., 2017). Premature replacement can also be driven by psychological obsolescence, particularly, among younger consumers since they are less concerned about product durability (Echegaray, 2016). Thus, product lifespan is shrinking over time; the more portable the device, the lower the expected lifespan resulting in rapid replacement of devices. Psychological obsolescence further plays a vital role in picturing how we consider a product to be obsolete and if it is worth repairing (Makov & Fitzpatrick, 2021). Furthermore, technical failure induces obsolescence that, in turn, motivates rapid replacement, while objective performance impacts perceptions of obsolescence; however, the interest in repair declines over time (Makov & Fitzpatrick, 2021).

Remanufacturing behavior

Remanufacturing behavior is another cluster that needs more attention. Awareness of swap programs and repair services is high among young Asians (Kuah & Wang, 2020), while product knowledge, remarketing, and the recapture process influence positive attitudes towards remanufactured products along with switching intentions (Wang et al., 2020). Particularly, the younger and more educated generation is more susceptible to switching and adopting remanufacturing behavior. However, regarding barriers, the fear of being cheated (in sharing platforms), low quality and reliability of remanufactured products, along with the low level of understanding of CE programs, adversely impacts consumers' WTP (Kuah & Wang, 2020). Also, because of less uncertainty, higher perceived quality, and higher trust in Original Equipment Manufacturers (OEM), consumers have higher WTP for manufacturer-remanufactured products (Xu et al., 2017). Therefore, suppliers (OEMs and remanufacturers) should present ample details on product history and circular recovery processes. Furthermore, as the profit of OEM is a big concern, it is suggested that offering financial incentives to the consumer would enhance the consumers' WTP and potentially solve the issue (Sabbaghi et al., 2016).

Return & collection behavior

Behavioral studies on "WEEE-return" are mostly focused on the smartphone, formal and informal channels, and reverse logistics. Still, this cluster lacks proper attention from scholars. Based on formal vs. informal channels used, distinct dissimilarities exist in the dismantling process of mobile phones. Very few returns happen through formal channels. For low-cost EEEs, consumers in close proximity to a storage facility are ready to return their product for a small incentive, while people who are further away from the facility would demand a higher incentive to return (Agarwal et al., 2012). For mobile phones, usually, the lack of formal collection channels (the biggest obstacle), the convenience of collection facilities, and the assurance of information security hinder the users' willingness to partake in WEEE collection or return (Tan et al., 2018). However, in a developing country context, high satisfaction has been observed with both channels, while the Internet platform has appeared to be a popular channel for disposing of mobile phones (Kumar, 2017). When it comes to reverse logistics or exchange programs for smartphones, multinational companies are at the forefront of the take-back mechanisms along with collection points, while domestic companies have yet to catch up. In this context, incorporating collection networks for mobile phones with the current government-led collection systems would help eliminate the concerns (Tan et al., 2018).

4.1.2 | Behavioral spillovers

Public understanding

Public understanding of e-waste usually incorporates household, commercial or professional levels. Research on understanding at the professional level lacks proper attention. Most IT professionals have good or very good knowledge and high awareness of e-waste and corresponding environmental issues. Also, most IT professionals believe

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and feel responsible in contributing to environmental issues concerning e-waste (Chugh et al., 2016; Hernandez, 2017). When it comes to demographic factors, such as gender, age groups, and organization size, the results vary sharply from culture to culture that demands future investigation in this paradigm. However, up until now, prior studies agree that "lack of budget" is the main concern in adopting and implementing sustainable green IT or work practices (Chugh et al., 2016; Hernandez, 2017).

The perception and understanding of the households play a significant role in e-waste management. Interestingly, most of the work on this stream has covered only developing economies (India, Bangladesh). In these regions, economic factors, such as warranty period, brand, competitive price, and installment options, are more important to households before they consider replacing them with a new ones (Islam et al., 2016). Social pressure plays a part in purchasing. The majority prefers repair or replacement after losing functionality and has the will but not the means to recycle, and a lack of awareness and knowledge persists. Finally, the young cohort is more concerned about conspicuous consumption or a prestige buy (Borthakur & Govind, 2018).

Sustainable CB

To explain the behavioral spillover of sustainability numerous enablers, such as subjective norms, PBC, attitude, government policy, education, advertisement or information dissemination, health benefits, and eco-labeling, were studied that can positively influence sustainable CB (Sheoran & Kumar, 2020, 2022). On the other hand, greenwashing by companies, high prices, lack of information, and the deficiency of the secondary product act as barriers to sustainable CB since they can negatively affect the attitude of the consumer (Sheoran & Kumar, 2022). Among the demographic factors, consumers, namely mid-income level, female, the young, and consumers with proper education, were found to behave more sustainably. Having a higher level of education further helps the government authorities and policymakers to influence individuals' conviction of disposal. Furthermore, when it comes to "individual conviction", positive word of mouth and self-awareness improve the disposal conviction, however e-waste hazard and social consequence do not (Jayaraman et al., 2019).

Law and regulation

When it comes to the impact of public policy and legal initiatives on people's behaviors, in e-waste literature a severe research gap exists. There is only one study from the USA showing the behavioral spillover of law and its impact on the reduction of the waste stream. The study shows that the outcome of the laws becomes more potent when people have increased market access via online connectivity and offline proximity (Dhanorkar & Muthulingam, 2020). Hence, more studies in developing regions are necessary to understand how people react to the law and its impact on the e-waste stream. Although, it is understandable that many of these nations still have no laws, hence research can be almost impossible to generalize the findings.

4.2 | Underpinning theories

Behavioral research in the domain of e-waste management uses different theoretical lenses. The famous TPB has been found as the core theory used and expanded by seminal studies over and over (see Table 5). Along with TPB, signaling theory, social capital theory, moral development theory, behavioral reasoning theory, and valence theory were the other important theories used and integrated to either create a conceptual model or explain a behavioral phenomenon. Table 5 below explicitly elaborates on the theoretical contribution of TPB as a core theory by illustrating the aim, independent, dependent, mediating, moderating, and control variables used and, of course, showing the theoretical implications and integrations with other theories.

4.2.1 | Theoretical integration with TPB

The well-established TPB has received enormous popularity because of its explanatory power regarding people's intention to execute a specific behavior. The antecedents of intention are PBC or behavioral control, attitude, and subjective norms (Ajzen, 1991). TPB offers a comprehensive model to evaluate multiple socio-psychological constructs of an individual's behavior that is mostly governed by intention. Prior studies found the antecedents of TPB were able to explain around 30% to 40% variation of the intention. Meanwhile, some studies in the CB literature found the variance to be around 60% when explaining pro-environmental behavior (Sabbir et al., 2022), showing the good predictive power of the model. Thus, over the years, it has stayed parsimonious and effective in examining human intentional behavior.

As the TPB can only explain 30%–40% of the variance of intention, it leaves room for other behavioral determinants to integrate. For instance, many scholars emphasized the fact that TPB lacks the incorporation of context-specific factors, which play a vital role in individual decision-making (Koshta et al., 2022). Moreover, in the CB literature, TPB has been criticized often for downplaying relevant non-cognitive predictors. It has more explanatory power when it is extended by integrating other context-related predictors (Sabbir et al., 2022). Therefore, it is crucial to extend the TPB model to enhance its predictive power, as it is proven that integrating two or more theories can stimulate greater knowledge of the phenomenon under research (Koshta et al., 2022). Thus, with a view to exploring people's intentions, numerous scholars did integrate other theories in the e-waste behavioral domain from pro-environmental behavior (PEB) (Aboelmaged, 2021; Koshta et al., 2022; Sabbir et al., 2022; Z. Wang et al., 2016), reverse supply chain or logistics (Kumar, 2017; Najmi et al., 2021), to developing context (Borthakur & Govind, 2018; Echegaray & Hansstein, 2017; Roy, 2016; Zhang et al., 2019). To better understand how different theories are integrated and interconnected to the TPB framework, Figure 9 graphically illustrates an integrated theoretical framework.

Within the pro-environmental context, factors, such as environmental protection, environmental consciousness, government initiatives, environmental knowledge, awareness, environmental

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TABLE 5 Underpinning theories and their implications.

Theory	Authors	IV	DV	Other variables	Implications/theoretical contributions
Theory of planned behavior (TPB)	Roy (2016)	Awareness, consumer cognition, risk perception	Recycling behavior, attitudes towards recycling	Mediating: Attitude toward recycling	• Extends TPB by integrating awareness, Cognition & Risk Perception from a developing context.
	Aboelmaged (2021)	Attitude, subjective norms, PBC, recycling habits	Recycling intention (young consumers)	NA	• Integrates recycling habits into TPB to explore key determinants of e-waste recycling intention among young consumers. • The integration of "recycling habit" augments the application of TPB in the pro-environmental (PEB) context.
	Echegaray and Hansstein (2017)	Attitude, social norm, PBC, awareness, environmental assessment, demographic variables: age, income, education, region, gender	Intention to recycle, behavior: Appropriate behavior for e-waste	Mediating: Intention to recycle	• Explains the pro-environmental behaviors in a developing context. • Extends TPB by incorporating the degree of awareness, environmental assessment, and socio-economic variables.
	Koshta et al. (2022)	Attitude, subjective norms, PBC, environmental concern, awareness of consequences	Intention to recycle, WTP of end user	Mediating: Intention to recycle	• Enhances the understanding of "polluters pay" in WEEE literature. • Extends TPB by integrating environmental concerns & awareness of consequences - context-specific factors.
	Kumar (2017)	Attitude, PBC, sense of duty, perceived benefit	Intention to recycle	Mediating: Attitude	• Enhance understanding of selling behavior on sustainable reverse supply chain. • "Sense of duty" & "perceived benefits" added to the extended TPB model.
	Zhang et al. (2019)	Perceived convenience, perceived revenue disadvantage, attitude, subjective norm, habit	E-commerce intention of e-waste recycling	MV: Facilities, subsidy	• Extends TPB by integrating TIB that highlights the role of habit & past behavior in the decision-making. • Contributes to explore the development of e-commerce in e-waste recycling from the perspective of residential behavior.
	Najmi et al. (2021)	Attitude, subjective norm, PBC, awareness of consequence, moral norms	Intention to recycle, reversing behavior	Mediating: Intention to recycle	• Contributes to the reverse logistics from the consumers' perspective. • Expanded TPB by integrating moral norms & awareness of consequence factors from altruistic behavior model of Schwartz.
	Sheoran and Kumar (2022)	Attitude, subjective norms, PBC	Sustainable consumer behavior intention.	MV: Age, gender, income, education	• Enhances understanding of the multidimensional nature of sustainable consumer behavior. • Different stages of consumption cycle have been integrated with TPB.
	Borthakur and Govind (2018)	Attitude, subjective norms, PBC, conspicuous consumption (status)	E-waste disposal intention	NA	• The idea of conspicuous consumption has been integrated with TPB to have a comprehensive view of e-waste disposal behavior

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TABLE 5 (Continued)

Theory	Authors	IV	DV	Other variables	Implications/theoretical contributions
					in a developing context (urban setting).
	Sabbir et al. (2022)	Attitude, subjective norm, PBC, government initiatives, consumer knowledge	Intention toward EOL electronic products exchange (EEPE) program	Mediating: Attitude toward EEPE, PBC, MV: Government initiatives	• Integrating TPB & A-B-C theory, this study showed that both attitude & context are essential in PEB. • Extends TPB model incorporating government initiatives & consumer knowledge.
	Wang et al. (2016)	Attitude, norms & publicity, environmental awareness, convenience of recycling, perceptions of informal recycling, costs of recycling, income, demographic variables (gender, age, education)	Intention to recycle	Mediating: Perceptions of informal recycling, costs of recycling	• Finds the significant factors that influence residents' intention to WEEE-recycling towards formal sectors. • Extends TPB by integrating environmental protection & consciousness.

Note: MV = Moderating variable, CV = Control Variable, WTP = Willingness to Pay, PEB = pro-environmental behavior.
Abbreviations: EEPE, EOL electronic products exchange; TPB, theory of planned behavior; WEEE, waste electrical and electronic equipment; WTP, willingness to pay.

assessment, environmental concern, recycling habits, and past behavior, etc., were integrated into the TPB (see Figure 9). Most of the time, the TPB has been extended to explore and explain the recycling behavior of individuals, residents, and young consumers. For instance, habits reflect an automated reaction that upholds repetitive activities in particular circumstances; hence, habits and past behaviors play a pivotal role in influencing pro-environmental behavior (Aboelmaged, 2021). To explain pro-environmental behavior, the TPB has been extended by incorporating socio-economic and socio-demographic constructs along with environmental assessment, degree of awareness (Echegaray & Hansstein, 2017), users' WTP for recycling, environmental concerns, awareness of consequences (Koshta et al., 2022), government initiatives, and consumer knowledge (Sabbir et al., 2022). Among these factors, some are context specific. To fill the lack of context-specific constructs' in the TPB, Sabbir et al. (2022) connected the Attitude-Behavior-Context (A-B-C) theory with the TPB to illustrate that both attitude and context are paramount in stimulating pro-environmental behavior (PEB). The inclusion of the A-B-C theory helps to better comprehend how contextual variables may influence pro-environmental attitudes to intention to perform PEB. While Zhang et al. (2019) extended TPB by incorporating the Theory of Interpersonal Behavior (TIB) to highlight the role of habit & past behavior, perceived convenience, and perceived revenue disadvantage in the decision-making of individuals. Their study further contributes to exploring the improvement of e-commerce or online platform-based WEEE-recycling from the perspective of residential behavior.

The foundation of a reverse supply chain design depends upon the buyers' and sellers' attitudes toward recycled products, networks, and structure of the recycling processes. Thus, in the context of the reverse supply chain or reverse logistics, the TPB model has been expanded by integrating factors such as sense of duty, perceived benefits (Kumar, 2017), awareness of consequences, and moral norms (Najmi et al., 2021). To explain the reverse logistics programs from the user's point of view, Najmi et al. (2021) coupled the Altruistic behavior model into the TPB since it was found to explain more variance from the intentional behavior. Meanwhile, sense of duty and benefits extend the understanding of a sustainable reverse supply chain to assist companies to plan the demand–supply mechanisms better. Also, government initiatives act as a contextual factor to explain the attitude–intention gap in reverse logistics (Sabbir et al., 2022), which has been affirmed by the A-B-C theory's relevance in reverse logistics' literature. Finally, the idea of conspicuous consumption (the prestige buys or status and throwaway culture) has been incorporated into the TPB to gain a holistic view of e-waste disposal behavior in developing economies (Borthakur & Govind, 2018). However, in the developing context, the majority of the research has been done at either the national level or urban level leaving room for more research on rural and peri-urban and specific demographic groups.

5 | IMPLICATIONS FOR FUTURE RESEARCH

Initially, the majority of WEEE research in the operations management field has been accomplished by focusing on mathematical models for efficient WEEE management. This leaves research on the end-user behavior of WEEE wide open from an operations and supply chain management (OSCM) perspective (Koshta et al., 2022). In earlier

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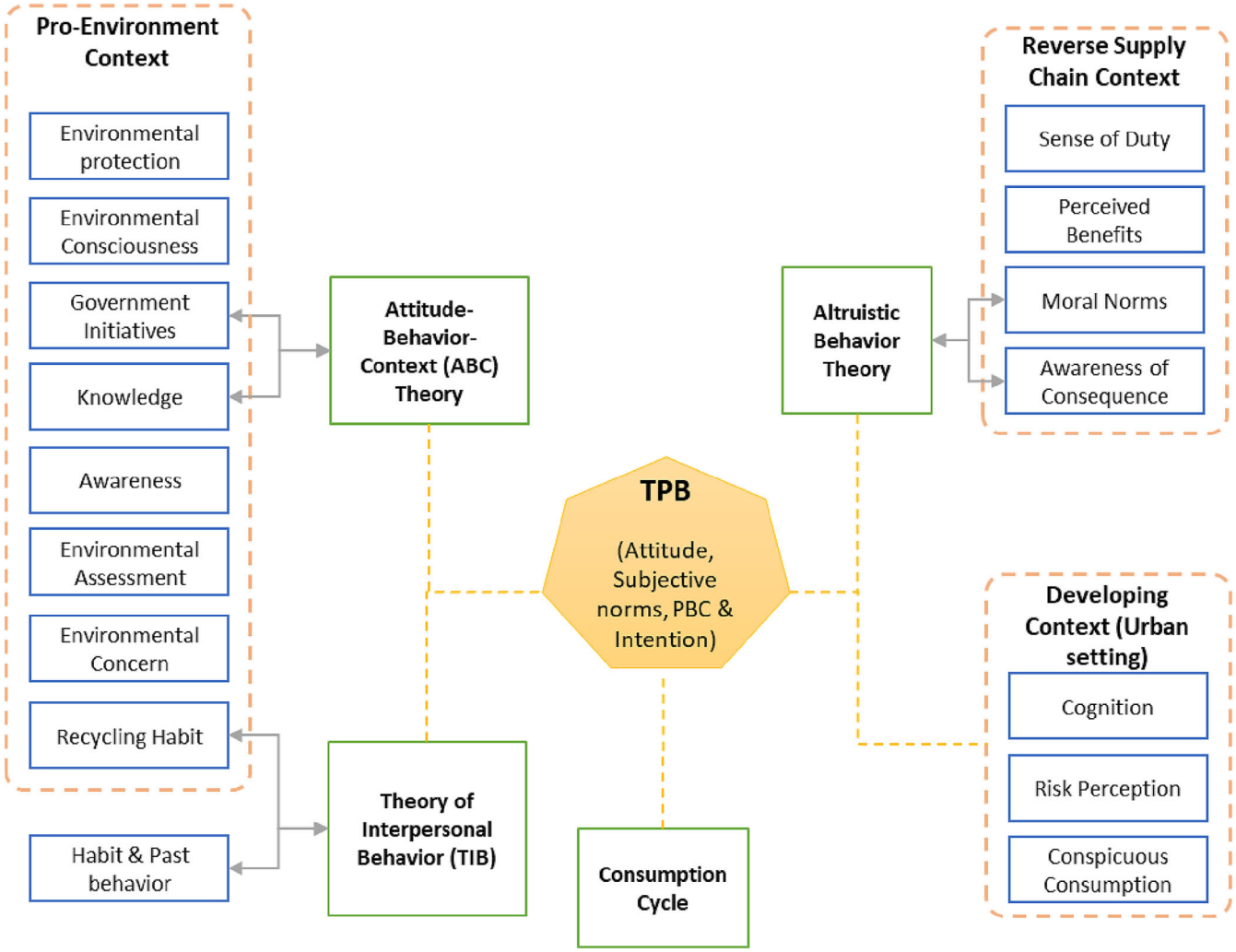

FIGURE 9 Theoretical integration and framework.

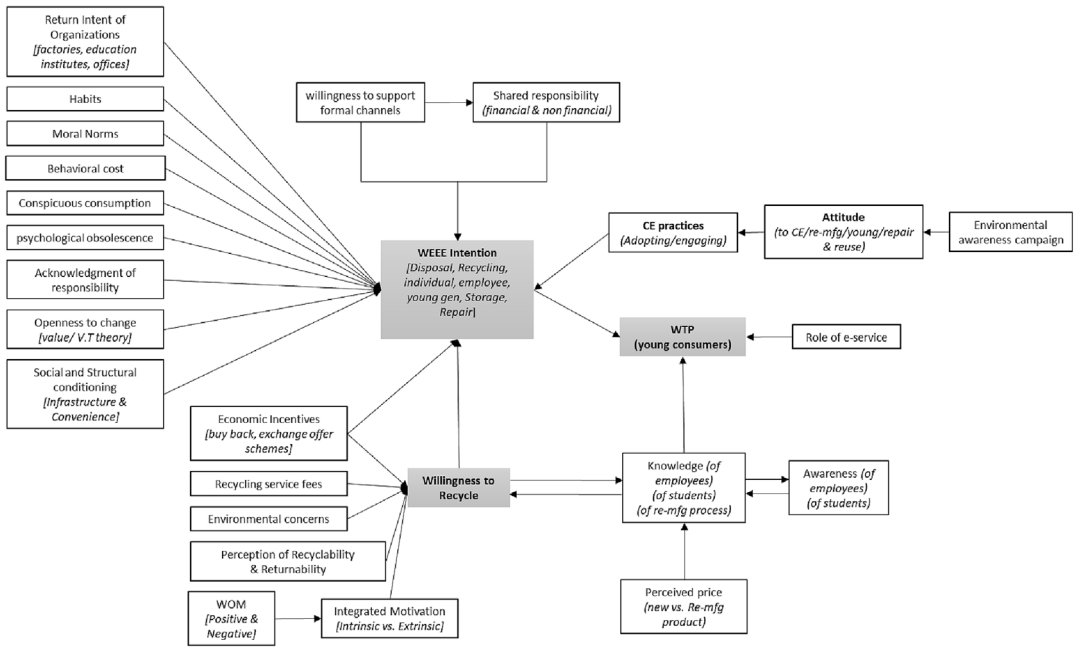

FIGURE 10 Conceptual framework for hypothesis test.

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Section 4.1, we maintained two broad categories of e-waste behavioral research streams divided into A) CE behavior and B) Behavioral spillovers. Here, based on the findings from those categories, the limitations and future research scopes are connected by conjoining the untested and prospective associations amid different constructs and concepts to test. Hence, a comprehensive conceptual model has been proposed (see Figure 10) that combines all possible gaps (untested hypotheses) in the WEEE-behavioral literature.

It is noteworthy that a big part of the model was formulated by connecting the recommended gaps or connections from the CE behavior category; particularly, recycling, remanufacturing, and return or collection. A few suggestions were placed from different behavioral spillover clusters. For instance, professionals or commercial disposal behavior, individual conviction, and public understanding are the areas where scholars pinpointed a few avenues for future research. This displays how nascent the behavioral spillovers' themes are in terms of law and regulation, EPR, sustainable consumption, the CE business model, and reuse behavior. Hence, future research should focus more on different kinds of behavioral spillovers and their implications in achieving sustainable development goals.

Table 6 below elaborates on the prospective relationships and further scope of studies in the proposed conceptual model in Figure 10. It is evident that "intention" in terms of disposal, recycling, and repair prove to be at the cynosure of the WEEE-behavioral model. Future studies need to investigate end users' intentions or pro-environmental behavior from different levels such as individual, commercial, professional, and young cohorts. Also, direct associations from antecedents such as habits, moral norms, behavioral cost, CE practices, openness to change, etc. should be tested against a broad range of WEEE intentions.

In this complex paradigm, "willingness to recycle" also acts as another strong factor, playing the critical role of mediation and being an endogenous variable at the same time. Different exogenous constructs, namely economic incentive, recycling service, environmental concern, and WOM, etc., must have some sort of linear or non-linear impact on the "willingness to recycle", which future studies need to test by keeping the "knowledge" and "awareness" of students, employees, and residents in mind.

Here, "knowledge" and "awareness" have an intricate role in this complex mechanism to establish the nexus amid "WTP", "willingness to

TABLE 6 Summary of future avenues of research for hypothesis testing.

Conceptual framework	Future research agenda on WEEE-behavioral domain
1.(Pérez-Belis et al., 2017) 2.(Wang et al., 2020) 3.(Kuah & Wang, 2020) 4.(Xu et al., 2017) 5.(Sabbir et al., 2022) 6.(Islam, Dias, & Huda, 2021) 7.(Aboelmaged, 2021) 8.(Najmi et al., 2021) 9.(Bai et al., 2018) 10.(Nnorom et al., 2009) 11.(Koshta et al., 2022) 12.(Dhir, Koshta, et al., 2021) 13.(Otto et al., 2018) 14.(Dhir, Malodia, et al., 2021) 15.(Chugh et al., 2016) 16.(Borthakur & Govind, 2018) 17.(Gilal et al., 2019)	• Impact of "environmental awareness campaign" on the "attitude toward repair & reuse". (1) • Investigate relationship between "knowledge of remanufacturing process" and "consumers intention" by controlling price difference. Focus on the knowledge offered by industries. (2) • Impact of "perceived price of new products" on their "knowledge" in terms of gathering remarket processes information & product history. (2) • Investigate how CE practices differ for different product categories by comparing the motivations & barriers to engaging in CE practices. (3) • How do demographic factors (e.g., income, size of household, age, education) impact end user's "attitude towards engaging in CE practices" for remanufactured goods. (3) • Investigate the role of different "e-services in the purchase intention" or WTP with diverse demographics. (4) • Examine if the "EOL electronic products exchange intention" can effectively predict "actual behavior". (5) • Explore the effect of non-cognitive, cognitive, and contextual factors and how they differ based on demographics in reverse logistics studies. (5) • Investigate the interconnectedness between repair & storage behavior and their impact on an incentive-based system. (6) • Investigate the role of "habits" on the e-waste "recycling intention". (7) • Confirm the insignificant effect of TPB variables on recycling intention (young consumer). Particularly, the effect of "moral norms" on "individual's intention". (7) • Investigate consumer participation in other settings; namely, reverse logistics programs, exchange programs, return, replacement. (8) • Investigate why despite "knowledge of recycling channels" consumers' or households' "willingness to recycle" is plummeting. (9) • Interrelation between 'WTP' and "prior knowledge" (expressed vs. real) needs more investigation. (10) • Need to explore the concept of "shared responsibility" and impact of "WTP" on the "price" or "properties" of the EEE in developing economies. (11) • Define the role of "economic incentives" on consumers' e-waste "recycling intention" and "motivation". (12) • Investigate the impact of different measures such as "social norms" and "financial enticements" on 'behavioral costs'. (13) • Investigate relationship between "openness to change value" and "intent to recycle" e-waste. (14) • Include the influence of "economic incentives" (e.g., exchange offers, and buyback offer, etc.) in the WEEE behavioral mechanism and propose a conceptual framework. (14) • Develop a global-level conceptual framework to implement environmentally sustainable work practices to demonstrate how employees can be maneuvered to implement sustainable ICT. (15) • Investigate young generation's behavior focusing on how "new brands" & "product outlooks" and "education" to form a conceptual framework. (16) • Investigate the influence of WOM on consumers' intrinsic & external motivations and their ultimate impact on WEEE 'disposal intention' or 'willingness to dispose' via organismic integration theory of SDT. (17)

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recycle", and "intention". This happens because both awareness (e.g., employees and students) and knowledge (e.g., professionals, industry, and young gen) are interrelated. Meanwhile, "knowledge" is a very versatile construct as it can incorporate a plethora of items such as knowledge of the remanufacturing and remarketing process, product & information, recycling channels, regulation, and sustainable development goals, etc., which can further be influenced by the perceived price (new vs. remanufacturing) of EEEs. Therefore, all these mentioned relationships conceptualize the complex proposed framework (Figure 10), which future studies need to explore, explain, and investigate.

Furthermore, to establish a robust model - a strong theoretical integration, or parsimony of theories, is vital for hypothesis testing. In this context, this study already proposes and explains the theoretical integration or expansion of the TPB with a robust theoretical framework (Section 4.2). There are strong suggestions from scholars to integrate theories, particularly to expand the TPB. For instance, the TPB has been criticized for overlooking social and structural conditioning, while crucial non-cognitive and contextual factors have been insufficiently studied in the recycling and reverse logistics literature (Echegaray & Hansstein, 2017; Sabbir et al., 2022). Hence, future conceptual models need to consider the "social embeddedness of post-consumption orientations", contextual factors, full consumption cycle (Sheoran & Kumar, 2022), and conspicuous consumption (Borthakur & Govind, 2018). Also, other seminal theories are suggested to be integrated either with the TPB or separately. For instance, Valence Theory might be integrated with the Value-Belief-Norm (VBN) theory concentrating on economic incentives (Dhir, Malodia, et al., 2021), while Signaling theory (Wang et al., 2020), Behavioral reasoning theory (Dhir, Koshta, et al., 2021), Moral development theory, and Theory of cognition (Jayaraman et al., 2019) are other seminal theories used in isolation to test the intention, willingness to recycle, and WTP. Hence, these mentioned theories need to be either integrated with the TPB or within the theories themselves to contribute to the e-waste management literature.

6 | CONCLUSION

We examined a sample of 293 articles in the field of WEEE-behavioral research, revealing the conceptual and intellectual structure of the field. Combining bibliometric and content analysis, we identified two main clusters: "CE behavior" and "behavioral spillover", with distinct research categories and streams. The CE behavior cluster encompassed recycling, return, remanufacture, replace, and repair behavior. The behavioral spillover cluster included categories like public understanding, sustainable CB, and law & regulation.

The majority of articles examined diverse behavioral aspects of e-waste management in emerging and developing countries, with a focus on pro-environmental practices, reverse supply chain dynamics, and urban contexts. Notably, China emerged as a dominant force with over 70% of the top institutes contributing to scientific production and citation impact in this field.

Another noteworthy finding is that within the "CE behavior" cluster, several articles adopt descriptive, mathematical model, text mining, or qualitative (interview) approaches, without explicitly referencing or incorporating any theoretical frameworks. These studies' context encompasses global, regional, national, urban, and semi-urban settings. The TPB has emerged as the core framework that extensively utilized and expanded upon in studies investigating return and recycling behavior. However, when exploring remanufacturing behavior and individual conviction, alternative theories such as signaling theory, behavioral reasoning theory, valence theory, social capital theory, theory of cognition, and basic psychological needs theory have been employed. These theories shed light on the complexities of circular economic behavior and diverse behavioral spillovers, presenting a comprehensive understanding of the subject.

While conducting this study, several limitations were encountered. The Bibliometrix package in R (Biblioshiny) has certain underdeveloped features, lacking options for removing duplicate documents or synchronizing multiple databases. This restricts its utility to analyzing a single database and limits compatibility with other bibliometric software. To overcome this limitation, a two-stage data extraction approach was employed. Initially, bibliometric data from WOS and Scopus were separately extracted and manual coding in R facilitated the removal of duplicates and the merging of databases for compatibility with Biblioshiny. Additionally, during the content analysis phase, all 293 abstracts were thoroughly reviewed to address limitations regarding abstract quality. When necessary, full-text reading was conducted to ensure the adequacy of articles for analysis. These measures helped to mitigate the impact of limitations and enhance the reliability of the findings.

Furthermore, we conducted our analysis based on studies available in the Scopus and WOS databases, focusing on publications indexed in ABS and ABDC. However, it is worth noting that some relevant studies from emerging countries may not be captured in these databases or fall within the ABS or ABDC indexes. Additionally, interdisciplinary articles offering insightful perspectives may not be included if they are not ranked by ABS or ABDC. Furthermore, our study was limited to English-language publications excluding articles in other languages because of accessibility and language comprehension constraints. Future research should consider incorporating articles from diverse languages and countries, particularly publications in Chinese. Moreover, it is important to acknowledge that our analysis primarily focused on original research and scientific journals within the business and management disciplines, omitting other valuable sources such as conference papers, book chapters, trade journals, reviews, and research notes. Despite these limitations, our study provides a systematic and rigorous examination of the evolution of WEEE-behavioral research, shedding light on high-impact and high-quality publications in the field.

This study unveils a captivating intersection where e-waste management meets behavioral research, unravelling a tapestry of compelling themes and unresolved inquiries. Our findings not only illuminate the current pulse of the field, but also offer a tantalizing glimpse into emerging research frontiers and untrodden pathways. With these revelatory insights in hand, we kindle the flame of curiosity, igniting a passionate pursuit of novel investigations and uncharted territories within the realm of e-waste management. We believe our analysis,

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discoveries, and visionary propositions set the stage for a vibrant future in WEEE-behavioral research.

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CONFLICT OF INTEREST STATEMENT

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APPENDIX A: FINAL SEARCH QUERY

TITLE-ABS-KEY (("e-waste" OR "e-waste electrical and electronics" OR "e-waste management" OR "WEEE" OR "Waste Electrical and Electronic Equipment" OR "electronic scrap" OR "obsolete electronics" OR "waste electronics" OR "electronic waste" OR "electrical waste" OR "waste electrical" OR "electronic rubbish" OR "electronic garbage" OR "end-of-life items") AND ("consumer e-waste disposal behaviour" OR "behavio*" OR "intent*" OR "dispos*" OR "discard*" OR "survey")).

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APPENDIX B: SUMMARY OF THE SEMINAL WEEE-BEHAVIORAL STUDIES

Authors	Category	Sub-category	Streams	Country	Type of analysis	Method	Sample	Context
Duran et al. (2022)	**Replacement behavior**	-	Replacement behavior of industrial WEEE (EOL solar panel)	United States	Quantitative	Mathematical model	NA	Developed
Pérez-Belis et al. (2017)		-	Repair/replacement & second-hand purchases habits (small EEE)	Spain	Quantitative	Survey, socio-economic study, generalized linear models (GLM)	400	Developed (urban)
Echegaray (2016)		-	Product obsolescence & replacement behavior (perceptions of product lifespan & longevity)	Brazil	Quantitative	Survey, descriptive statistics	806	Developing (urban)
Makov and Fitzpatrick (2021)	**Repair behavior**	-	Planned obsolescence & consumers interest in repair of smartphone	NA	Quantitative	Big data analytics, benchmarking score	3,541,554 results	Global
Raihanian Mashhadi et al. (2016)		-	Common failures, repair practices & challenges (individual consumer)	United States	Quantitative	Text mining techniques, regression analysis	4,210 narratives	Global
Wang et al. (2020)	**Remanufacture behavior**	Circular economy	Perceptions of remanufactured products (knowledge & info on intention)	China	Quantitative	Survey, experts' opinion, covariance-based SEM	906	Developing
Kuah and Wang (2020)			Recycle & remanufacture, consumer acceptance on CE practices	Asia	Quantitative	Exploratory survey, pilot study, demographic study, descriptive statistics	584	Regional
Xu et al. (2017)		-	Willingness to pay (WTP) of remanufactured products & customer behavior in CLSC (smarttech)	United States	Quantitative	Big data, predictive analytics, multiple regression	8,947 auctions & 2,748 transactions	Developed
Sabbaghi et al. (2016)		-	Consumers' participation in take-back systems & consumers' decision	United States	Quantitative	Game theory decision-making framework, mathematical model	NA	Developed
Tan et al. (2018)	**Return behavior**	Mobile phone	Returning & recycling preferences	China	Quantitative	Survey, descriptive statistics	296	Developing (urban)
Kumar (2017)			Reverse supply chain OR return management of formal & informal channels	India	Quali-Quanti (pluralistic methodological approach)	Survey & in-depth interview	Survey = 220, interview = 40	Developing (urban)

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Authors	Category	Sub-category	Streams	Country	Type of analysis	Method	Sample	Context
Agarwal et al. (2012)		-	Low cost EEE - return behavior (EOL goods)	India	Quantitative	Mathematical model (particle swarm optimization approach) & survey	450	Developing
Sabbir et al. (2022)		-	Sustainable post-consumption behavior (PEB) & consumers' reverse exchange (RL) behavior	Bangladesh	Quantitative	Survey, factor analysis, SEM	Study 1: 334study 2: 330	Developing (national)
Islam, Dias et al. (2021)	**Recycling behavior**	Young consumers	Consumption & recycling behavior	Australia	Quantitative	Survey, Chi-square tests, descriptive statistics, Weibull distribution	440	Developed (urban)
Aboelmaged (2021)			(Determinants) recycling habit	United Arab Emirates (UAE)	Quantitative: (multivariate statistical analysis)	Partial least squares structural equation modeling (PLS-SEM)	379	Developing
Najmi et al. (2021)		EOL mobile phones/ smartphone	Recycling programs OR reversing behavior	Pakistan	Quantitative	Two staged SEM & artificial neural network	746	Developing (urban)
Bai et al. (2018)			Recycling behavior	China	Quantitative	Survey, descriptive statistics	820	Developing (national)
Nnorom et al. (2009)			Recycling (willingness to pay premium)	Nigeria	Quantitative:	Survey, principal component analysis - varimax rotation	1,000	Developing (Semi-Urban & Rural)
Koshta et al. (2022)		Households	Willingness to pay (WTP) for the recycling & polluters' pay	India	Quantitative	Cross-sectional survey, partial least squares path modeling (PLS-PM)	382	Developing
Dhir, Koshta, et al. (2021)			Recycling attitudes & intentions (environmental assessment & concerns)	Japan	Quantitative	Cross-sectional survey, SEM	774	Developed
Otto et al. (2018)			Behavioral costs & environmental motivation for recycling	Germany	Quantitative	Survey, field trial with structural interventions, one-dimensional probabilistic model	141	Developed
Wang et al. (2016)			Recycling behaviors (perceptions of informal channels)	China	Quantitative	Survey, exploratory factor analysis (EFA) & SEM	525	Developing (national)
Roy (2016)			Recycling & societal behavior	India	Quantitative	SEM	242	Developing (local)
Chi et al. (2014)			Recycling behaviors	China	Quali-quanti	Survey, field observations & secondary data	430	Developing (urban)

(Continues)

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Authors	Category	Sub-category	Streams	Country	Type of analysis	Method	Sample	Context
Wang et al. (2011)			Recycling behavior & preference	China	Quantitative	Survey, logistic regression model	957	Developing (urban)
Dhir, Malodia, et al. (2021)		-	Recycling behavior & consumers' decision	Japan	Quantitative	Cross-sectional survey data, SEM	774	Developed
Zhang et al. (2019)		-	Recycling behavior/ acceptance of e-commerce &psychological & contextual variables	China	Quantitative	Survey, ordered logit regression	895	Developing (national)
Peng et al. (2018)		-	Recycling behavior at enterprise level(social capital, governance & willingness)	China	Quantitative	Survey, SEM	688	Developing (national)
Echegaray and Hansstein (2017)		-	Pro-recycling behavior & socio demographic characteristics	Brazil	Quantitative	Survey, ordered probit regression & logit regression	806	Developing (urban)
Liu et al. (2021)		-	Social recycling behavior & stakeholders' perspective	China	Quantitative	Interviews, decision-making trial and evaluation laboratory (DEMATEL) model	5	Developing
Sheoran and Kumar (2022)	**Sustainable consumer behavior (health, environment, enablers)**	-	Complete consumption cycle of household EEEs	India	Quantitative	Pilot study, survey, expert opinion, PLS-SEM and multi-group analysis	700	
Sheoran and Kumar (2020)		-	Sustainable consumer behavior & enablers	India	Quantitative	Interpretive structural modelling, MICMAC analysis	200	Developing (urban)
Afroz et al. (2013)		-	Public knowledge, awareness & willingness to pay (WTP) of household	Malaysia	Quantitative	Survey (face to face)	350	Developing
Hernandez (2017)	**ICT professionals' behavior**	-	Environmentally sustainable practices, awareness & practices of IT professionals	Philippines	Quantitative	Survey, descriptive statistics	104	Developing
Chugh et al. (2016)		-	Green ICT awareness & sustainable practice	India	Quali-quanti	Survey & open-ended questions, descriptive statistics	25 org (73 employee)	Developing

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Authors	Category	Sub-category	Streams	Country	Type of analysis	Method	Sample	Context
Borthakur and Govind (2018)	**Public understanding & disposal behavior**	Household level	Public understanding & disposal behavior, computer & smartphones	India	Quali-quanti	SLR & survey, descriptive statistics	300	Developing (urban)
Islam et al. (2016)			Assess WEEE management trend (WEEE generation)	Bangladesh	Quantitative	Pilot test & survey, descriptive statistics	400	Developing (urban)
Orlins and Guan (2016)		Professionals level	Collectors & recyclers informal workers' knowledge (environmental impacts)	China	Qualitative	Ethnographic semi-structured interviews, primary & secondary research	12	Developing (sectoral)
Jayaraman et al. (2019)	**Individual conviction**	-	Individual conviction on laptop disposal practices	Malaysia	Quantitative	Cross-sectional survey, PLS-SEM	123	Developing
Gilal et al. (2019)		-	Social behavior changes & self-reported disposal behavior	Pakistan	Quantitative	Surveys, SEM with maximum likelihood method	300	Developing (national)
Dhanorkar and Muthulingam (2020)	**Legislation**	Behavioral spillovers of law	Public policy initiative on consumer behaviors	United States	Quantitative	Quasi-experimental setup with longitudinal panel dataset	14 years	Developed (national)

Abbreviations: CE, circular economy; EFA, exploratory factor analysis; GLM, generalized linear models; ICT, information and communication technology; PLS-PM; partial least squares path modeling; PLS-SEM; partial least squares structural equation modeling; SEM, scanning electron microscope; TPB, theory of planned behavior; WEEE, waste electrical and electronic equipment; WTP, willingness to pay.

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