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Evolution of Behavioral Research on E-Waste Management: Conceptual Framework and Future Research Directions

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Abstract

Electronic waste the fastest-growing solid waste stream has evolved as a domain drawing substantial attention among scholars. Particularly, research in the field of behavioral studies is on the rise. While reviews on e-waste have proliferated, a paucity prevails on WEEE-behavioral review studies. Thus, this study aims to perform a bibliometric review study on WEEE-behavioral research in two phases combining both 1) bibliometric and 2) content analysis to provide a systematic and holistic review. First, bibliometric analysis was done using VOSviewer and Biblioshiny (R package) on a sample of initial 293 articles combining SCOPUS and WOS databases. The bibliometric part initially determines the evolution of WEEE-behavioral research, most productive nations, journals, themes, and clusters via bibliographic coupling-based network analysis, co-occurrence, co-citation analysis, Sankey diagram, impact analysis with global and local citation, etc. Second, content analysis has been done with 41 relevant articles that are able to answer the research questions. Hence, in terms of findings from the bibliometric and content analysis, this study presents: 1) the evolution of the WEEE-behavioral domain via bibliometric analysis 2) underlying main research streams with a framework, and 3) avenue of future research with a robust conceptual model to hypothesize.

Keywords*: e-waste management, scientometric analysis, content analysis, thematic mapping.*

Introduction

According to a report by United Nations (UN), the yearly generation of electronic waste (WEEE) is more than 44 million metric tons which is equivalent to about 4500 Eiffel towers (Aboelmaged, 2021), which is further predicted to rise to 74.7 million tons by 2030 (Dhir, Malodia, Awan, Sakashita, & Kaur, 2021). The annual growth rate of e-waste was around 45%, (Dhir, Koshta, Goyal, Sakashita, & Almotairi, 2021) with an approximated 4% to 5% spike (yearly) has made this the fastest-growing waste stream. Also, e-waste is growing three times faster compared to other solid wastes; thus, presenting a formidable challenge to manage (Roy, 2016), particularly, for developing economies.

The end-users act as the garrison for e-waste, as they define its trajectory. Recently, the 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, for the improvement of 'e-waste management' a better understanding of the behavioral paradigm is essential (Islam, Huda, et al., 2021).

A handful of contemporary literature reviews have concentrated on different facets of e-waste and consumer behavior. These extant reviews cover topics such as relationships among consumer behavior (CB) constructs (Gilal, Shah, Adeel, Gilal, & Gilal, 2022), implication of CB on circular economy (CE) (Islam, Huda, et al., 2021), conceptual framework for disposal behavior (Phulwani, Kumar, & Goyal, 2021), finally, testing new conceptual framework in an urban context (Borthakur & Govind, 2018). Interestingly, most of these studies focused on proposing conceptual models from consumer behavior perspectives, while none has focused on the evolution of WEEE-behavioral research using bibliometric analysis. Hence, motivated by this research gap while employing a bibliometric approach, the research questions of this study are: (RQ1) What are the key journals, influential institutions, countries, impactful and trending topics in the field of e-waste behavioral research? and (RQ2) How do the WEEE-behavioral domain has evolved over time, and what are the underlying research streams? (RQ3): What are the possible directions for future research on WEEE-behavioral domain in the field of business and management?

Methodology

Bibliometric and content analysis methods

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.

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). Hence, in this study, the potential of content analysis has been optimized by combining bibliometric methods (Bretas & Alon, 2021).

Both VOSviewer software and the Bibliometrix package in the R-studio have 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.

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, Anderson, Munim, & Ho, 2018).

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 database the two most acknowledged bibliographic databases (Aria & Cuccurullo, 2017). These two seminal databases complement each other by maximizing the identification of relevant studies (Rejeb, Suhaiza, Rejeb, Seuring, & Treiblmaier, 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 fig.01*).

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).

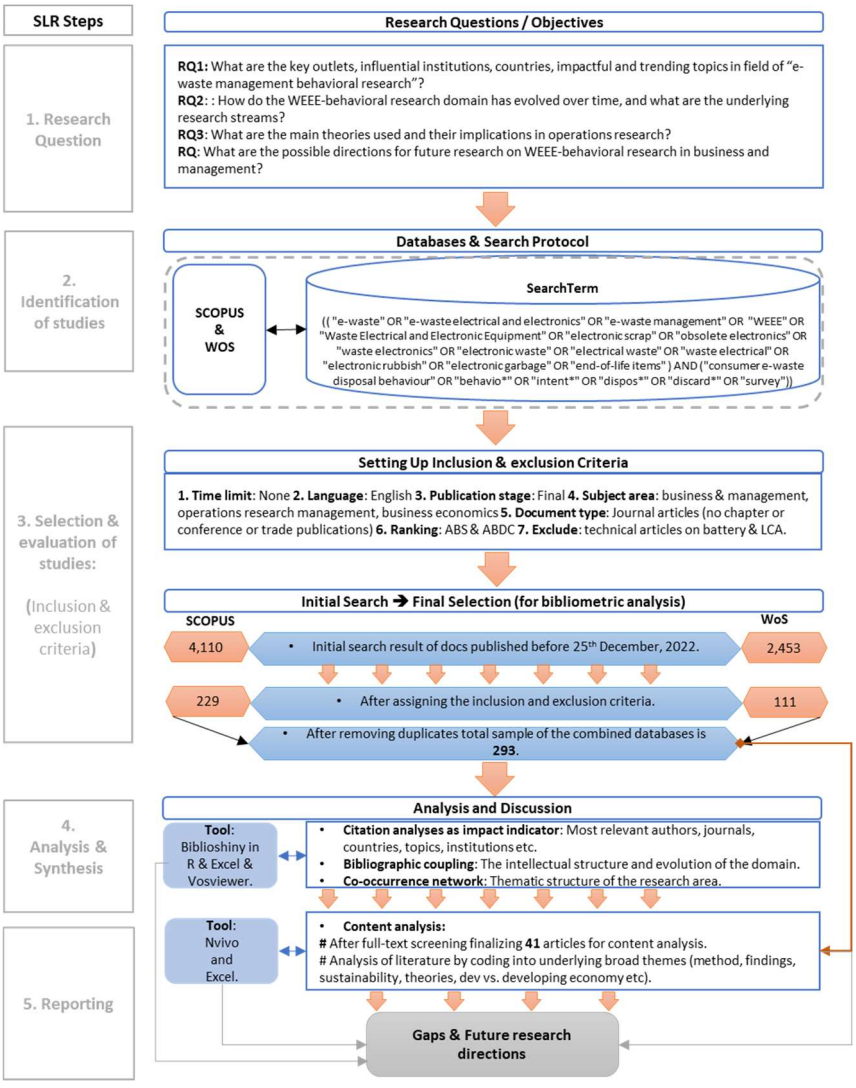

Figure 01: Methodological flowchart for bibliometric and content analysis review.

The search protocol considers 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. Different selection criteria were employed to pinpoint the articles that should

either be screened out (exclusion criteria) or be considered (inclusion criteria) (Tranfield, Denyer, & Smart, 2003). These refinements resulted in a total of 4,357 articles.

At the initial phases of the search, 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 specifying the subject area to business economics, operations research management, and business & management in order to evade the disparities in research outputs by guaranteeing a more detailed breakdown of this area while stimulating adequate generalizability (Rejeb et al., 2022). Thus, this refinement has dragged down 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, duplicative documents were taken out using the R-studio application, which also helped to compile these two databases into one big excel (CSV) file for the bibliometric analysis. The screening led to the selection of 293 publications for a further review.

Finally, after extracting the final sample of 293 articles for the bibliometric analysis full text of each article was closely scrutinized. Hence, at this phase, a set of 41 relevant articles was retained for the content analysis. This approach helps to determine the leading research categories and streams, trends, and recommendations for future studies (Bretas & Alon, 2021).

Bibliometric analysis

Multiple techniques: namely, co-citation analysis, citation analysis, and bibliometric coupling are usually employed for bibliometric analysis. Considering the research questions, citation analyses have been performed to reveal the most relevant institutes, top authors, articles, and journals. While bibliographic coupling helped to recognize the structure or interconnections of the literature as it is more suitable to pinpoint 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.

Preliminary data statistics

In total 898 authors had written 293 articles (the final sample) that were published in 119 journals. On average, each article received 28.96 citations. 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 7 articles). However, from 2016 till 2022 (Dec) it spiked to 208, depicting 73.5% of the total sample. The year 2021 had seen the highest number of citations.

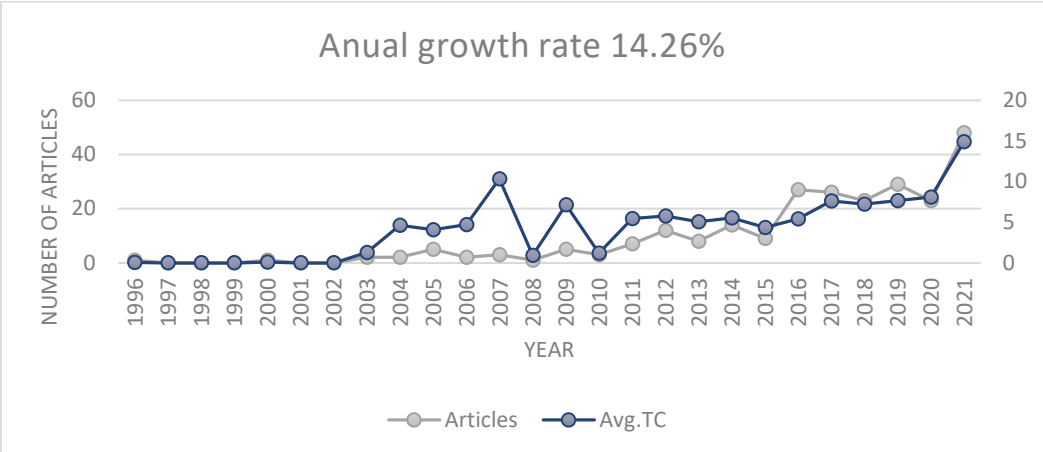

Figure 02: Year wise growth of scientific production

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. As this is a transdisciplinary topic, the journals also represent diverse academic areas such as strategy and management, 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 4700 citations. The dispersion is way too big since there are only 3 other journals that published more than 5 articles on this emerging field: International Journal of Production Economics (9 articles), International Journal of Production Research (6 articles), and Business Strategy and The Environment (6 articles). The same ranking goes for these same 04 journals in terms of impact (h-index) assessment.

To examine the impacts of the journals further, they were split into 04 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. 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, here, 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 parallels the Y-axis is the average number of articles while the red line parallels the X-axis is the average citation.

Among the 12 journals, only Journal of cleaner production belongs to quadrant A, with the highest number of publications and citations. Journal of Business research is the only journal in quadrant B with higher-than-average citations but fewer publications. With 07 journals (POM, EJOR, TFSC, IEAE, 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 03 journals (BSE, IJPE, and IJPR) showing higher focus but low impact. For more detail, journals in the quadrants are labeled in the right part of Figure 3.

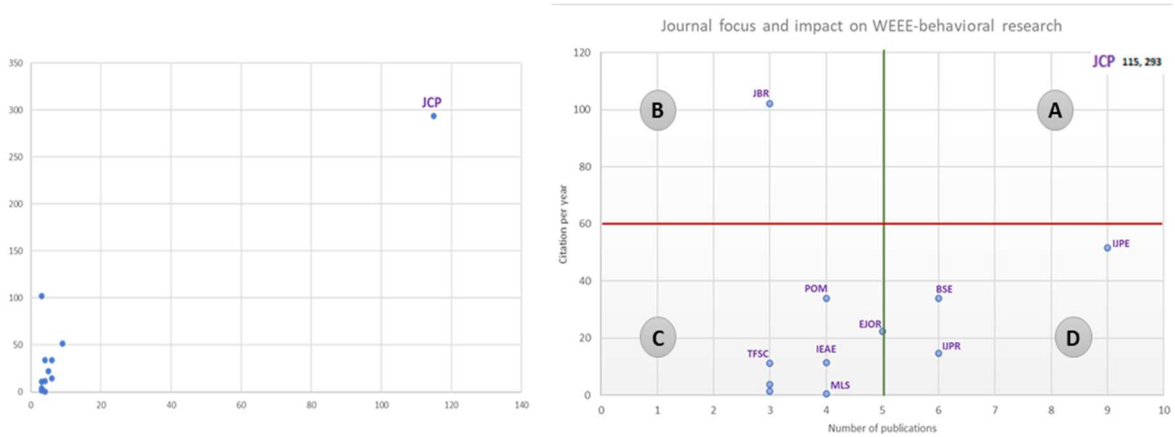

Figure 3: Journal impact & focus by 2 X 2 matrix

The top 10 relevant studies in the domain of e-waste and behaviour are presented in table 01. The impact of these articles is illustrated by both total global (TGC) and local (TLC) citations. As per the TGC/t Z. Wang, Guo, and Wang (2016) turns out to be the most influential; however, following the TLC/t the study of Z. Wang, Zhang, Yin, and Zhang (2011) is the most significant. Most of the influential studies are from the Chinese context focusing on different behaviours and intentions (e.g., recycling, collection, reuse, disposal, etc.).

Table 01: Top 10 most relevant articles

Rank	Author-Year (sorted by TLC/t)	TGC	TGC/t	TLC	TLC/t
1	Z. Wang et al. (2011)	204	17	19	1.58
2	Z. Wang et al. (2016)	136	19.43	11	1.57
3	Chi, Wang, and Reuter (2014)	134	14.89	10	1.11
4	Nnorom, Ohakwe, and Osibanjo (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, Masud, Akhtar, and Duasa (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

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

Concerning the number of contributions, the top 03 institutions researching e-waste and behavioral aspects are all from China: Tsinghua University (25 articles); China University of Mining and Technology (18 articles); 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 (8 articles), Italian (7 articles), and Austrian (6 articles) institutes are at the forefront. Therefore, it seems like behavioral research in 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 04). These findings also hold that major contributions are coming from institutions in emerging countries, although USA and UK also have significant contributions in terms of impact or citation.

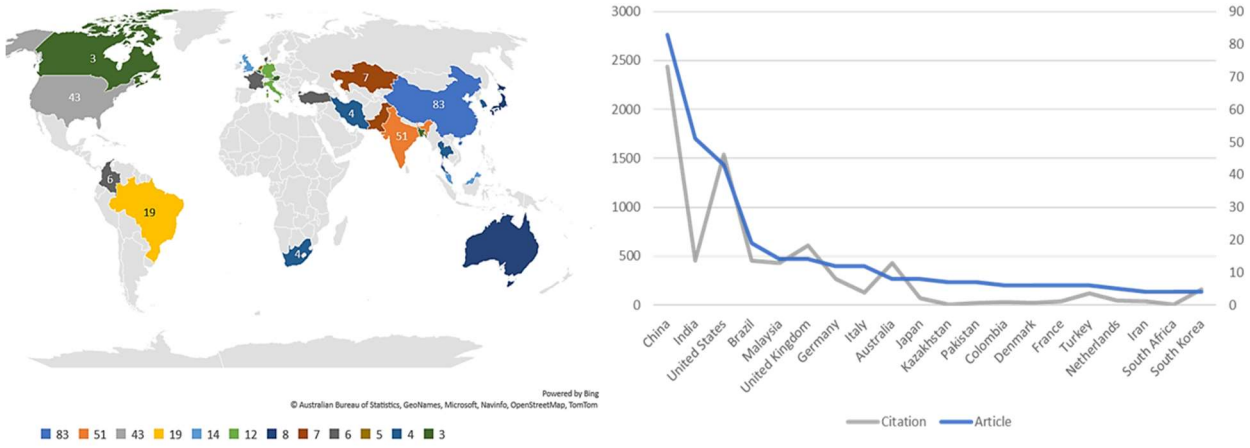

Figure 4: Country map

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 4 clusters that we labeled numerically (see figure 5). There are 2 main dominating clusters which 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.

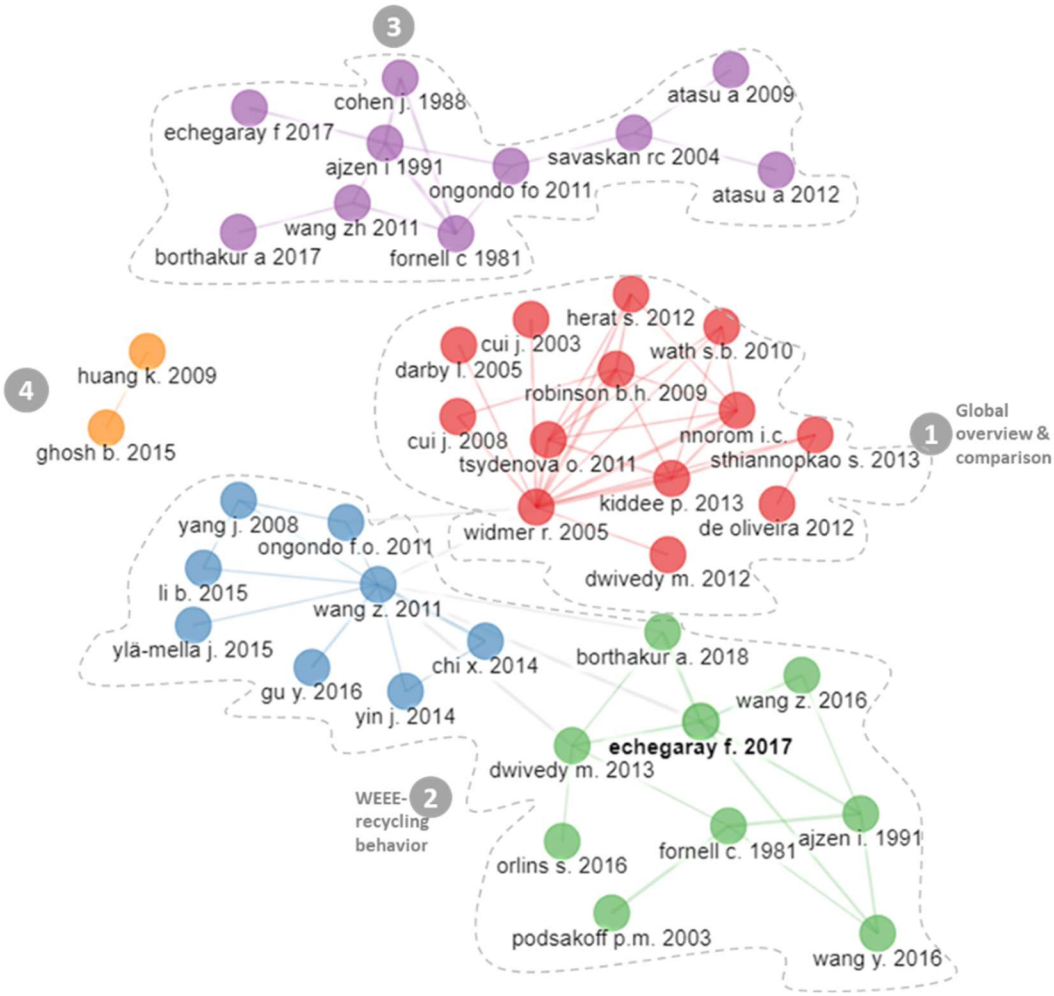

Figure 05: Bibliographic coupling showing linkages across articles.

The first cluster (Number 1) is labeled as "global overview and comparison". The studies in the cluster split into two main research categories. The first one is focused 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, Naidu, & Wong, 2013; Nnorom & Osibanjo, 2008; Robinson, 2009; Widmer, Oswald-Krapf, Sinha-Khetriwal, Schnellmann, & Böni, 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, Bernardes, & Gerbase, 2012; Sthiannopkao & Wong, 2013), and sustainability issues in emerging regions (Dwivedy & Mittal, 2012; Wath, Vaidya, Dutt, & Chakrabarti, 2010).

The second cluster (Number 2) is named "WEEE-recycling behavior". The studies in this cluster concentrate on different factors of household and consumer behavior 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; Z. Wang et al., 2011); determinants of consumer recycling intentions (Fabian Echegaray & Hansstein, 2017), attitudes, and willingness to pay (Yin, Gao, & Xu, 2014), awareness and perceptions (Ylä-Mella, Keiski, & Pongrácz, 2015); collection channels of WEEE and household recycling behaviors (Chi, Wang, & Reuter, 2014); knowledge & perception of remanufactured products (Y. Wang & Hazen, 2016); perceptions of informal recycling (Z. Wang et al., 2016); 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 (Fabian Echegaray & Hansstein, 2017) and residents' willingness to recycle (Z. Wang et al., 2011).

Temporal evolution of themes

Figure 07 demonstrates the temporal transition of themes using the keywords over 3 timelines (1996-2004, 2005-2013, and 2013–2021) representing the most frequent and looming themes (Bretas & Alon, 2021).

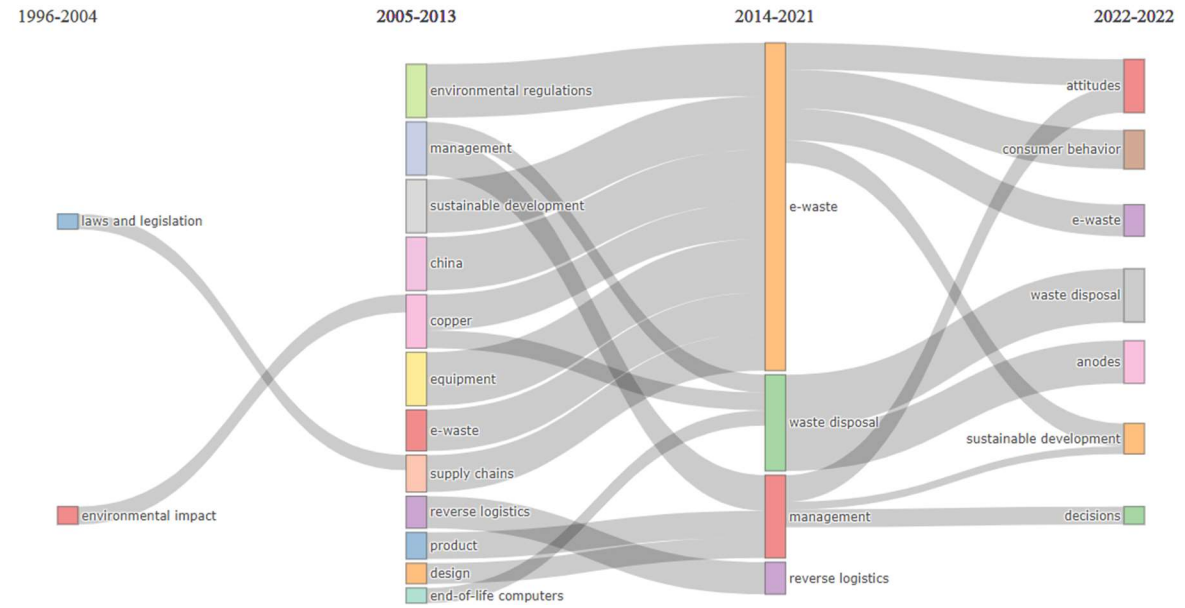

Figure 07: Temporal evolution of keywords

Between 1996 and 2004, themes related to WEEE "regulation", and its "environmental impact" emerged; hence, no substantial scholarly attention. During 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, between 2013–2021, these scattered themes began to converge and ripened into 04 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 has truly matured in this stretch. However, the new branch of behavioral research in WEEE has only been triggered to evolve with continuous prominence in the past 02 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 prowl in this paradigm.

Content analysis and discussion

Content analysis helps to specify and document fairly objective features of research that make the results more plausible (Maditati, Munim, Schramm, & Kummer, 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). The major clusters are divided into different categories and research streams, types of study, methods, and context used.

Research categories and streams

Based on the content analysis of these 41 seminal studies, two clusters namely A) circular economy 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 consumer behavior, and law & regulation. Figure 9 presents the resulting research framework combining the clusters and corresponding categories and research streams.

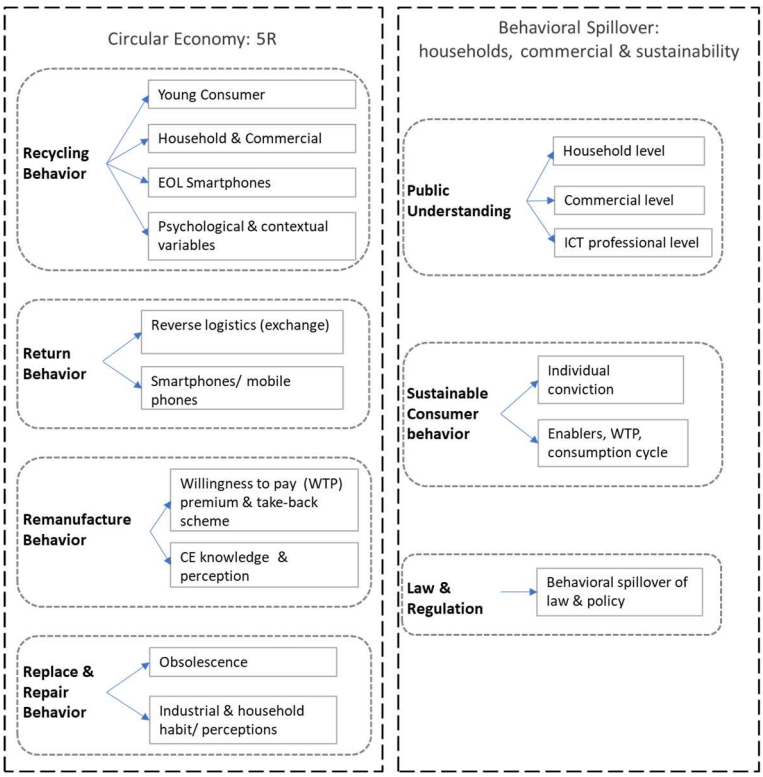

Figure 09: WEE behavioral research framework

Circular economy 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, Patra, & Singh, 2022; Otto, Kibbe, Henn, Hentschke, & Kaiser, 2018; Z. Wang et al., 2016), and EOL mobile phones (Bai, Wang, & Zeng, 2018; Najmi, Kanapathy, & Aziz, 2021; Nnorom, Ohakwe, & Osibanjo, 2009) are the main streams that mostly used psychological and contextual variables by integrating and extending the theory of planned behavior (Aboelmaged, 2021; Fabian Echegaray & Hansstein, 2017; Koshta et al., 2022; Najmi et al., 2021; Roy, 2016; Zhang, Du, Wang, & Wang, 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 to reflect into practice. Thus, a proper awareness program is a must-have to correct the WEEE disposal behavior. In terms of psychological factors, attitude and habits act as important enablers to recycle; however, the effect of behavioral control and subjective norms did not result in significant support for the recycling intention.

Currently, due to the miniaturization effect and faster obsolescence smartphones have become a major contributor to e-waste. Moral norms and attitude were found 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.

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 theory of planned behavior (TPB), behavioral reasoning theory (BRT), Valence Theory, etc. The most common factors were willingness to pay (WTP) (Koshta et al., 2022; Nnorom et al., 2009), attitude (Dhir, Koshta, et al., 2021; Fabian Echegaray & Hansstein, 2017; Z. Wang et al., 2016; Zhang et al., 2019), subjective norms (Fabian 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; Z. Wang et al., 2016), convenience or comfort (Otto et al., 2018; Z. Wang et al., 2016; Zhang et al., 2019) and behavioral control (PBC) (Fabian Echegaray & Hansstein, 2017; Koshta et al., 2022) that were tested against the intention to recycle. Also, different demographic variables were tested against intention too (Dhir, Malodia, et al., 2021; Fabian Echegaray & Hansstein, 2017).

Replacement and repair behavior

Replacement and repair behavior are important yet less explored topics, also these two behaviors are interconnected. The most typical repair practice is replacement since unprofessional individuals are not able to repair complicated parts (Raihanian Mashhadi, Esmaeilian, Cade, Wiens, & Behdad, 2016). Also, people usually do not opt for repair due to component repair costs, knowledge about repair shops, and inconvenience of transport which altogether influences their decision-making process. Premature replacement can also be driven by psychological obsolescence, particularly, among younger consumers since they are less concerned about product durability (Fabián 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 worthwhile to repair (Makov & Fitzpatrick, 2021). Furthermore, technical failure induces obsolescence that in turn motivates rapid replacement, while, objective performance impacts perceptions of obsolescence, however, the interest to 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 Asian (Kuah & Wang, 2020), while product knowledge, remarketing, and recapture process influences positive attitudes towards remanufactured products along with switching intentions (Y. Wang, Zhu, Krikke, & Hazen, 2020). Particularly, the younger and more educated generation is more susceptible to switching and adopting remanufacturing behavior. However, as 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' willingness to pay (WTP) (Kuah & Wang, 2020). Also, due to less uncertainty, higher perceived quality, and higher trust toward Original Equipment Manufacturers (OEM), consumers have higher WTP for manufacturer-remanufactured products (Xu, Zeng, & He, 2017). Therefore, suppliers

(OEMs and remanufacturers) should present ample details on product history and circular recovery processes.

Return & collection behavior

Behavioral studies on 'WEEE-return' are mostly focused on smartphone, formal and informal channels, and reverse logistics. Still, this cluster lacks proper attention from scholars. Based on formal vs. informal channels used, there exist distinct dissimilarities in the dismantling process of mobile phones. Very few returns happen through formal channels. For low-cost EEEs, consumers in close proximity to the storage facility are ready to return their product for a small incentive while people who are far away from the facility would demand a higher incentive to return (Agarwal, Barari, & Tiwari, 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, Duan, Liu, Yang, & Li, 2018). 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 are 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).

Behavioral spillovers

Public understanding

Public understanding of e-waste usually incorporates household or 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 and feel responsible to contribute to environmental issues concerning e-waste (Chugh, Wibowo, & Grandhi, 2016; Hernandez, 2017). When it comes to demographic factors such as gender, age groups, and organization size the results sharply vary from culture to culture which demands future investigation in this paradigm. However, up until now prior studies agrees that 'lack of budget' is the main concern to adopt and implement sustainable greet IT or work practice (Chugh et al., 2016; Hernandez, 2017).

Sustainable consumer behavior

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 consumer behavior (Sheoran & Kumar, 2020, 2022). On the other hand, greenwashing by companies, high prices, lack of information, and deficiency of the secondary product act as barriers to sustainable consumer behavior since they can negatively affect the attitude of the consumer (Sheoran & Kumar, 2022). 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 improves the disposal conviction, however, e-waste hazard and social consequence do not (Jayaraman, Vejayon, Raman, & Mostafiz, 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 gets 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.

Avenue 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 behaviour of WEEE wide open from an operations and supply chain management (OSCM) perspective (Koshta et al., 2022). We maintained two broad categories of e-waste behavioural research streams divided into A) CE behaviour and B) Behavioural spillovers. Here, 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 11) that combines all possible gaps (untested hypotheses) in the WEEE-behavioural literature.

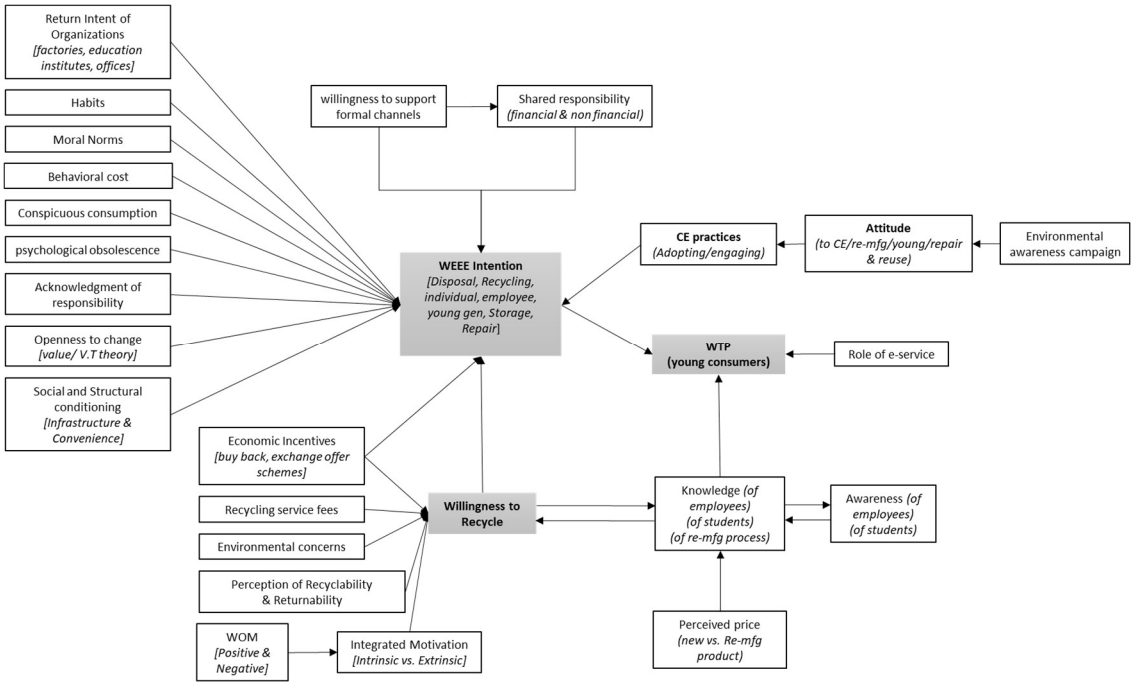

Figure 11: Conceptual framework for hypothesis test.

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

It is evident that 'intention' in terms of disposal, recycling, and repair turns out to be at the cynosure of the WEEE-behavioural model. Future studies need to investigate end users' intentions or pro-environmental behaviour from different levels such as individual, commercial, professional, and young cohorts. Also, direct associations from antecedents such as habits, moral norms, behavioural 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 mediating and an endogenous variable at the same time. Different exogenous constructs: namely, economic incentive, recycling service, environmental concern, 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 recycle', and 'intention'. This happens because both awareness (e.g., employees, students) and knowledge (e.g., professionals, industry, young gen) are interrelated. While 'knowledge' is a very versatile construct as it can incorporate a plethora of items such as knowledge of remanufacturing and remarket process, product & information, recycling channels, regulation, sustainable development goals, etc. which can further be influenced by perceived price (new vs. remanufacturing) of EEEs. Therefore, all these mentioned relationships conceptualize the complex proposed framework (figure 11) 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. There are strong suggestions from scholars to integrate theories, particularly, to expand the TPB. For instance, 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 (Fabian Echegaray & Hansstein, 2017; Sabbir, Khan, Das, Akter, & Hossain, 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 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 (Y. 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 TPB or within themselves to contribute to E-waste management literature.

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