ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

DOTTORATO DI RICERCA IN

PSYCHOLOGY

Ciclo XXXVII

Settore Concorsuale: 11/E3 PSICOLOGIA SOCIALE, DEL LAVORO E DELLE ORGANIZZAZIONI

Settore Scientifico Disciplinare: M/PSI 05 PSICOLOGIA SOCIALE

Promoting collection, reuse and recycling of electrical and electronic equipment

Presentata da: Gabriele Puzzo

Coordinatore Dottorato

Mariagrazia Benassi

Supervisore

Gabriele Prati

Esame finale anno 2025

Table of Content

1. Abstract

E-waste poses significant environmental challenges, yet recycling rates remain low despite established infrastructure. Existing research has explored psychological drivers of recycling intentions but lacks insights into how these intentions translate into actions, the role of situational factors, and the potential of digital nudging to promote sustainable behaviours. This PhD thesis addresses these gaps through three interconnected studies, offering a comprehensive approach to enhancing e-waste management practices. The first study conducts a worldwide meta-analysis of 36 studies to identify key psychological antecedents of e-waste recycling behaviour, such as attitudes, convenience, and policy effectiveness, using constructs from prominent behavioural theories. These findings provide a robust theoretical foundation for understanding recycling behaviours. The second study investigates the influence of situational factors, including proximity and user experience of collection centres, on bridging the intention-behaviour. Using structural equation modelling with data from 700 participants gathered in Italy, the study demonstrates how convenience enhances recycling behaviours through normative and gain-based goals. The third study evaluates digital nudging strategies, specifically social comparison feedback, in influencing recycling and purchasing behaviours. An experimental survey of 524 Italian participants reveals nuanced effects, offering practical insights for designing pro-environmental digital interventions. Together, these studies provide actionable strategies to advance sustainable e-waste management and bridge critical research gaps.

Borsa di dottorato del Programma Operativo Nazionale Ricerca e Innovazione 2014-2020 (CCI 2014IT16M2OP005), risorse FSE REACT-EU, Azione IV.4 “Dottorati e contratti di ricerca su tematiche dell’innovazione” e Azione IV.5 “Dottorati su tematiche Green."

J35F21003260006

2. Introduction

Waste from Electrical and Electronic Equipment (WEEE), also known as e-waste, has become a central topic in discussions about resource sustainability, largely due to the rapid expansion and relentless innovation within the technological industry. This growth has resulted in an ongoing e-waste crisis characterized by an ever-increasing volume of discarded electronic devices. The improper disposal of e-waste by consumers who lack adequate knowledge about appropriate disposal practices poses significant environmental risks. Such practices not only contribute to environmental degradation but also impede the efficient recovery of valuable materials contained in e-waste, which could otherwise be repurposed or recycled.

Given the critical role consumers play in the lifecycle of electronic products, effective e-waste management begins with understanding and influencing consumer behaviours. Addressing this, the current PhD project is designed with three overarching goals in mind. Firstly, the project aims to deepen our understanding of the psychological factors that drive e-waste recycling intentions and behaviours. This will be achieved through a meta-analysis of existing literature conducted worldwide, providing a consolidated and encompassing view of the psychological antecedents that influence how and why individuals choose to recycle their e-waste. By identifying these factors, the project will contribute to a more robust theoretical framework for understanding recycling behaviour in a variety of contexts and geographical locations.

Secondly, the research will explore how various environmental factors impact the conversion of recycling intentions into actual recycling behaviours. This will be investigated through a structural equation modelling approach, which will clarify how environmental variables—such as collection centres distance, opening hours, and user experience—affect the likelihood of individuals to perform concrete actions in an under-researched study area such as the Italian context. This aim seeks to bridge the gap between intention and behaviour by providing insights into the external and contextual influences that facilitate or hinder recycling practices.

Finally, the project will test an innovative solution aimed at enhancing pro-environmental behaviours through digital nudging. Digital nudging involves the strategic design of digital environments to subtly guide individuals towards more sustainable choices without restricting their freedom. By experimentally assessing the effectiveness of after-action digital nudging techniques, the project will evaluate their potential in promoting sustainable reuse and e-waste recycling in an under-researched study area - Italy. This component of the research aims to provide practical tools and interventions that can be applied in digital platforms and services to encourage more effective e-waste management.

This PhD project was developed in collaboration with one of Italy's leading multi-service companies, a major national utility listed on the stock exchange since 2003 and operating across five regions (Emilia-Romagna, Veneto, Friuli-Venezia Giulia, Marche, and Toscana), serving over 4.2 million citizens. The company's strong commitment to sustainability, circular economy principles, and innovation provided a unique and fertile context for investigating pro-environmental behaviours in the domain of e-waste management. Their involvement was not merely logistical but strategic: they contributed to the study design by aligning the research questions with real-world challenges and business priorities, thereby ensuring the practical relevance of the findings. The partnership also allowed access to key data, insights, and operational realities, strengthening the ecological validity of the three studies. This collaboration was instrumental in bridging academic inquiry with applied environmental strategies, particularly in supporting the company's efforts to meet 11 of the 17 UN 2030 Agenda goals through targeted investment and behavioural innovation.

Overall, this PhD project aims to make a significant impact on the field of e-waste management by deepening our understanding of consumer behaviour, clarifying the influence of environmental factors, and exploring effective digital strategies. By integrating insights from psychological research, environmental science, and digital technology, the project will provide valuable knowledge on practical solutions to enhance e-waste recycling and promote sustainable disposal practices. This comprehensive approach is designed to offer actionable strategies for improving e-waste management, ultimately contributing to more effective and sustainable environmental practices.

3. Chapter 1: An overview on e-waste management

3.1. The e-waste crisis

Waste from Electric and Electronic Equipment (WEEE), also known as electronic waste (e-waste), comprises end-of-life products that operate using electrical currents or electromagnetic fields but are no longer wanted, functional, or are considered obsolete (UNEP, 2007). E-waste includes old appliances such as laptops, computers, mobile phones, TVs, DVD players, refrigerators, freezers, washing machines, medical devices, information technology, and telecommunications systems devices (Habib et al., 2022).

E-waste is widely regarded as the world's fastest-growing waste stream (Parajuly et al., 2019), whose current trends are expected to double by 2045 (Unitar, 2024). The rapid increase in e-waste has been driven by exponential advances in information and communication technology (Shobande & Ogbeifun, 2021), the growing diversity of electronic devices (Phulwani et al., 2021), the increased speed of invention and technological progress (Berman & Dalzell-Payne, 2018), and increasing population and urbanization (Tansel, 2017). Furthermore, rapidly changing consumer preferences have resulted in the constant replacement of electronic products with newer ones that have shorter lifespans (Borthakur & Govind, 2018). For instance, in 2005 China and India, personal computers (PCs) and their central processing units (CPUs) were replaced every 2–3 years, compared to approximately 4–6 years in 1997 (Brigden et al., 2005).

Therefore, the rise in electrical and electronic device usage, higher consumption rates, and increased obsolescence rates have led to a rapid increase in the volume of e-waste produced worldwide (Thukral et al., 2023). The Global e-waste Monitor Report 2024 of The United Nations shows that global e-waste production is increasing at a rate of roughly 2.3 million tonnes annually, estimating that it would grow to 82 million metric tons by 2030 (Unitar, 2024). These figures clearly display a growing trend in e-waste production and a further increase from the same report published in 2020, which estimated e-waste generation to reach 75 million tons by 2030 (Unitar, 2020). If this trend goes on,

countries in Europe, Oceania and Americas will be the leading ones in terms of e-waste output by 2050. Figures 1, 2, and 3 clearly depict increasing e-waste production rates worldwide.

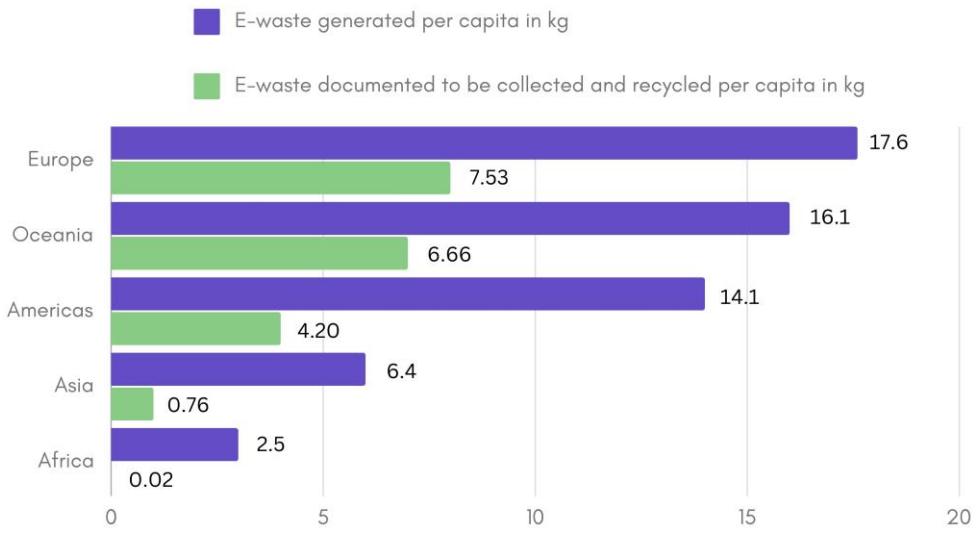

Figure 1. E-waste generation per capita in kg according to continent, adapted from Unitar (2024)

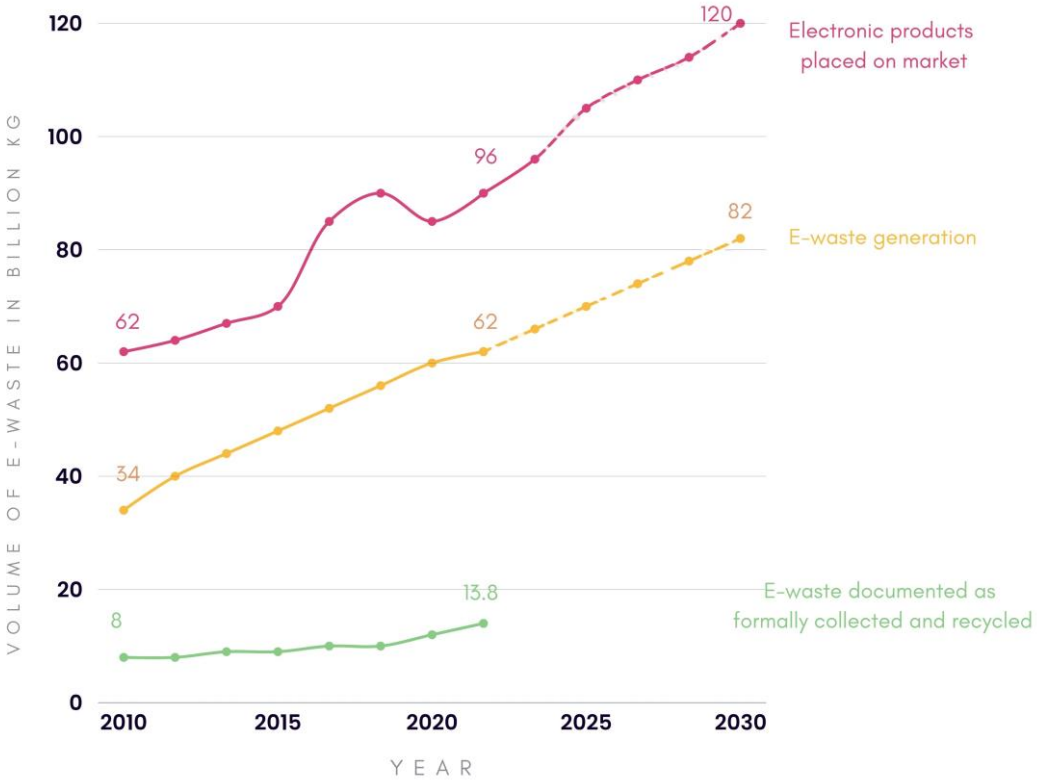

Figure 2. E-waste generation and formal collection from 2010, adapted from Unitar (2024)

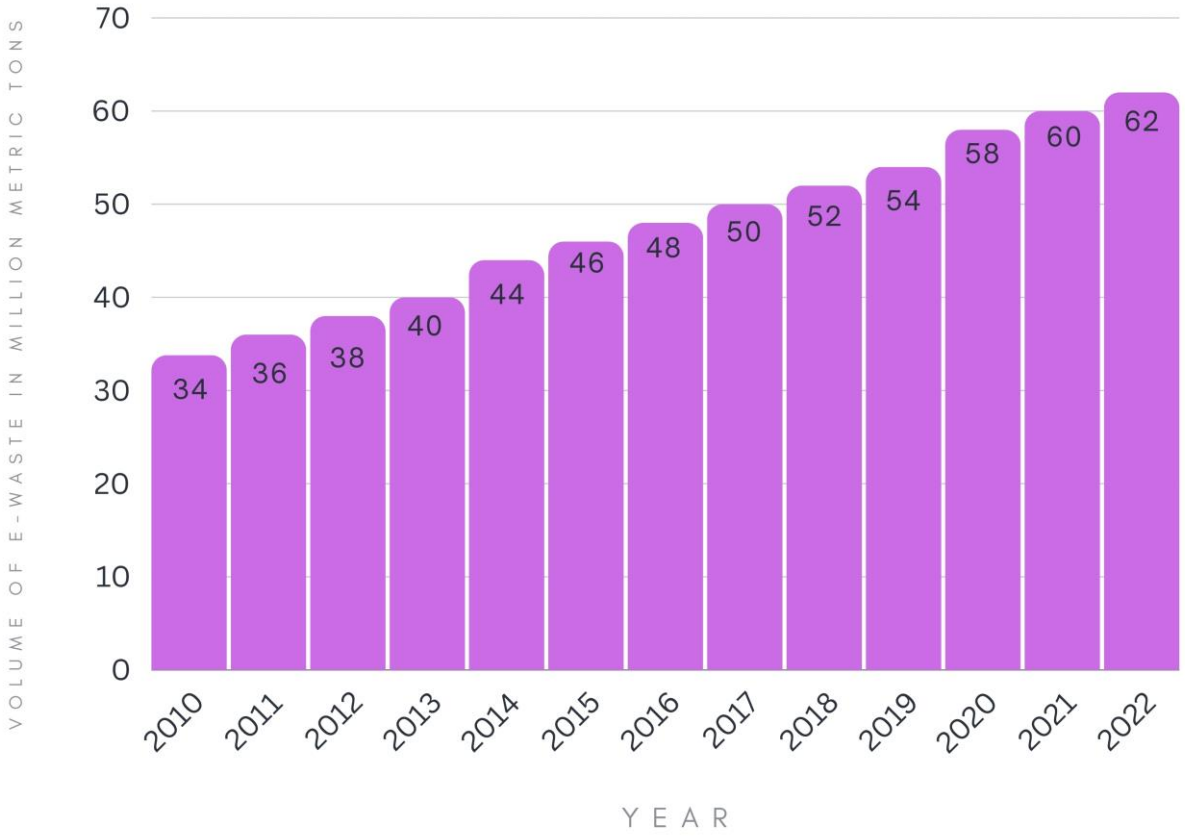

Figure 3. Global e-waste generated by year, adapted from Thukral and colleagues (2023)

Managing e-waste has thus become an increasingly pressing problem worldwide named "the e-waste crisis", as it negatively impacts on human health, environment, and economy. Electronic products consist of various materials that require specific treatments at the end of their life cycles. For example, the e-waste generated in 2022 included 31 billion kg of metals, 17 billion kg of plastics, and 14 billion kg of other materials such as minerals, glass, and composites (Unitar, 2024). Proper disposal of e-waste through advanced collection infrastructures is essential because improper management can release harmful substances like mercury, lead, plastics, and greenhouse gases into the environment, posing risks to human health. Exposure to these poisonous and toxic substances can affect thyroid function, increase the incidence of cancer, skin and lung diseases, and cause damage to the central nervous system, kidney and bone (Nongkynrih et al., 2017).

The Global E-waste Monitor reports that of the 62 million tonnes of e-waste produced in 2022, only 13.8 million tonnes were collected and recycled in an environmentally sound manner. The remaining 48.2 million tonnes were either collected outside formal recycling systems in high and middle-income countries (16.2 million tonnes), mishandled in lower-income countries without adequate e-waste management infrastructure (18 million tonnes), or discarded as residual waste (14 million tonnes). As a result, inadequate e-waste management leads to the annual release of 58,000 kg of mercury and 45 million kg of plastics containing brominated flame retardants into the environment (Unitar, 2024), making e-waste a source of concern in terms of environmental protection and resource recycling (Perkins et al., 2014).

Incorrect e-waste management negatively impacts the global economy, as well. In 2022, existing e-waste management practices converted approximately USD 28 billion worth of metals into secondary raw materials globally. However, these practices still incur a net cost of approximately USD 37 billion, mainly due to externalized health and environmental costs from unmanaged hazardous substances and greenhouse gas emissions. Despite the benefits from metal recovery (USD 28 billion) and avoided greenhouse gas emissions (USD 23 billion), when these are deducted from the costs of e-waste treatment (USD 10 billion) and externalized health and environmental costs (USD 78 billion), the net loss remains an all-time high in the history of e-waste management (Unitar, 2024).

3.2. E-waste management around the globe

The generation and management of electronic waste (e-waste) vary significantly across the globe, reflecting differences in economic development, regulatory frameworks, and infrastructure. For instance, there is a noticeable correlation between a region's per capita purchasing power and the volume of e-waste it produces. Typically, higher-income regions generate more e-waste due to their higher consumption of goods and greater access to electronic and electrical equipment (EEE). Additionally, countries that implement and enforce e-waste management through legally binding measures, such as setting collection and recycling targets or establishing e-waste legislation or policies, achieve an average formal collection and recycling rate of 25 percent. In contrast, countries

lacking such legislation, even in draft form, exhibit collection rates of 0 percent (Patil & Ramakrishna, 2020). Comparisons also reveal disparities in disposal behaviours across different regions and subregions within a continent. In many low-income areas, the informal sector plays a crucial role in e-waste management. Although the informal sector's impact can be substantial, it is rarely captured in official data or monitored by governments. Informal recycling practices frequently lead to low resource-efficiency and fail to comply with environmental, health, and safety standards (Unitar, 2024).

Advanced infrastructure for e-waste disposal is essential for efficient recycling and material recovery. Although it generates the most e-waste, Europe has the highest recorded per capita collection and recycling rates (7.53 kg per capita) largely due to its sophisticated collection and recycling systems (Unitar, 2024). E-waste was first prioritized as a waste stream in Europe in 1990, leading to the publication of the EU WEEE Directive in 2002. This Directive places stringent requirements on producers through the Extended Producer Responsibility (EPR) system, holding them accountable for the disposal of their electronic products to promote improved waste management (Atatsu, 2018). The WEEE Directive mandates EU member states to facilitate separate collection and resource recovery from e-waste, improving recyclability and integrating end-of-life (EoL) considerations during product design. Concepts like 'design-for-recycling' and the European Ecodesign Directive further support this by setting design requirements for energy-related products to encompass all lifecycle stages, including EoL (Parajuly et al., 2020). Given the wide variety of EEE products, the EU has classified e-waste into six distinct categories (Islam et al., 2021). Table 1 shows the categories and sample products, and legislative provisions of recovery, reuse, and recycling for the member states.

Table 1. E-waste product categories according to EU WEEE Directive, 2012/19/EU, adapted from Islam and colleagues (2021)

No.	E-waste category	Sample e-waste product	Target	
			Recovered (%)	Prepared for re-use or recycled (%)
1	Temperature exchange equipment	Refrigerators, freezers, air conditioners	85	80
2	Screens, monitors with surface screens > 100cm^2	Televisions, monitors, laptops, tablets	80	70
3	Lamps	Fluorescent lamps, LED lamps	-	80
4	Large equipment	Washing Machines, clothes dryers, dish-washing machines	85	80
5	Small equipment	Vacuum cleaners, microwaves, ventilation equipment	75	55
6	Small information technology and telecommunication equipment	Mobile phones, pocket calculators, routers, desktop computers	75	55

Summing up, systems that include effective collection processes, specialized treatment facilities, and legal instruments - such as the environmental policy principle of EPR – facilitate countries to recycle more e-waste. However, these systems usually can be afforded by high-income countries which, indeed, are the ones that produce more e-waste per capita. Moreover, growth rate of countries implementing e-waste policies, legislation, or regulations is slowing, according to data from June 2023. Currently, 81 countries (42% of all countries worldwide) have adopted e-waste policies, covering 72% of the global population. Significant limitations remain in environmentally sound recycling practices due to low collection rates and limited recycling infrastructure in many parts of the world (Unitar, 2024).

For example, the supervision of the collection and treatment of e-waste in Italy pertains to the body “Centro di Coordinamento RAEE” (CdCRAEE). Moreover, to fulfill the EPR principle for WEEE, producers have joined together in the ERION consortium, which has the task of managing the transport and end-of-life treatment of e-waste on behalf of the producers (Centro di Coordinamento RAEE, 2024). Despite that, in Italy (but it happens in a similar way throughout Europe and the world) almost the overall amount of the WEEE collected is disposed of at “scrap dealers”, which shred the waste entirely to separate metals, plastics and cement. Sorted and shredded waste is then sent to specialized recycling plants through generally energy-intensive processes (mechanical recycling or

depolymerization for chemical recycling of plastics, re-casting of metals). The waste thus processed is then transformed in secondary raw material available for manufacturing (Unitar, 2024)

As a consequence, on 25 July 2024, the European Commission launched an infringement procedure by sending a letter of formal notice to Italy (INFR(2024)2097) for failing to correctly transpose the Waste Framework Directive (Directive 2008/98/EC on waste). The Commission found that Italy had failed to correctly transpose several provisions of the amended Directive, including those on EPR, ensuring high-quality recycling, separate collection of hazardous waste and implementing an electronic traceability system. Italy also failed to enhance citizens' involvement in disposing of their old e-products, as it didn't achieve the minimum collection rate for e-waste, set out in Article 7(1) of Directive 2012/19/EU.7 (European Commission, 2024).

3.3. The 4 routes of e-waste management

As previously noted, the 62 million tonnes of e-waste generated in 2022 were disposed of through one of four distinct "routes": formal e-waste collection and recycling systems, disposal in residual waste, or collection outside formal systems, with or without established e-waste management infrastructures. Route 1, formal e-waste collection, remains the most efficient and environmentally sound method for e-waste treatment. In the 81 countries with legal frameworks for e-waste, these activities are regulated, with designated organizations, producers, and governments responsible for collection via retailers, municipal points, or pick-up services. In 2022, 13.8 billion kg of e-waste were collected through these formal channels, and 6 billion kg of metals were recovered in specialized treatment facilities. These facilities ensure that valuable materials are reclaimed under controlled conditions while hazardous substances are safely managed. However, 1 billion kg of metals were lost or could not be recovered during the formal recycling process. The primary challenge remains the establishment of effective collection systems and the increase of collection rates, as currently, only 22.3 percent of global e-waste is processed through formal management channels.

In fact, in 2022 an estimated 14 billion kg of e-waste were improperly disposed of globally, often mixed with regular household waste, particularly in high- and upper-middle-income countries (Route 2). Smaller e-waste items like lamps, small IT devices, and small equipment are typically discarded with residual waste and treated as regular mixed household waste. Larger items, on the other hand, may be collected as bulky waste and either incinerated or dumped in landfills, depending on the waste management infrastructure of the country, often without any material recycling. Some high-income countries do attempt to recover metals through methods like magnet separation or recycling the bottom ash from municipal solid waste incineration, resulting in an estimated recovery of 80 million kg of metals according to the Global E-waste Monitor datasets and modelling. However, a significant number of metals—around 7 billion kg—are still lost during incineration or landfilling. Simply discarding e-waste in this manner is not an appropriate treatment method due to the potential environmental harm and significant resource losses, which is why such disposal practices are prohibited under most e-waste legislation.

Moreover, approximately 16 billion kg of e-waste were collected through informal channels in countries with developed e-waste management systems (Route 3). This e-waste is typically managed by individual waste dealers or companies operating outside formal collection schemes, primarily in high-income and upper-middle-income nations. The e-waste is gathered and traded through various channels, with some potentially directed towards metal or plastic recycling. However, hazardous substances are often not properly decontaminated. Moreover, a portion of this e-waste may be exported as uncontrolled waste or used electronic equipment to low- and lower-middle-income countries with insufficient e-waste management infrastructure. This route proves to be inefficient, resulting in significant resource loss and environmental damage.

Finally, in many low- and middle-income countries a substantial number of self-employed individuals engage in informal e-waste collection and recycling (Route 4). These individuals collect used electronic equipment and e-waste from households, businesses, and public institutions, often going door-to-door. The collected items are then sold for repair, refurbishment, or dismantling. Dismantlers

manually break down the equipment into marketable components, while recyclers employ methods such as burning, leaching, and melting to convert e-waste into secondary raw materials. This "backyard recycling" process often lacks proper treatment standards, resulting in the release of harmful substances like acids, dioxins, and furans. This route is the least desirable due to its inefficiency, significant resource loss, severe environmental pollution, and health risks to workers and local communities. Occasionally, valuable materials are sold to e-waste recyclers in high-income countries, where they are treated under more environmentally sound conditions. It is estimated that approximately 7 billion kg of metals are recovered from the 18 billion kg of e-waste managed through this route (Unitar, 2024).

While future scenarios on improvement of e-waste will be decided by the extent to which e-waste management infrastructures, legislation, and technology will be developed across the world, it is important to highlight the crucial importance of citizens and electronic products consumers to avoid that e-waste follows route 2. Reviews clearly point out that the starting point for corresponding e-waste management practices is consumers' behaviour (e.g., Parajuly et al., 2019; Parajuly et al., 2020; Islam et al., 2021), as they have the agency to decide where and how to dispose of their e-waste. Goal 12 of the United Nations Sustainable Development Goals (UN SDGs) emphasizes that responsible consumption and production can be achieved by promoting recycling and reducing toxic waste among consumers (UN, 2020). If most people would not improperly dispose of e-waste in residual bins and, on the contrary, use "formal" collection systems, the quantity of WEEE managed in an environmentally sound way would almost double (Unitar, 2024). Consequently, if countries can increase e-waste collection and recycling rates to 60% by 2030, the benefits, including reduced human health risks, would surpass the costs by over USD 38 billion (Unitar, 2024).

After conducting a national survey on U.S. households, Saphores and colleagues (2012) stated that understanding consumers' intentions and behaviours regarding e-waste management play a "key role" to help reduce the impact that the e-waste crisis is having on the environment, human health, and economy (Saphores et al., 2012). However, if the benefits of proper e-waste management are so

important, what are the reasons behind people's neglect to properly dispose of e-waste? Psychology is the discipline that can help answer this question.

4. Chapter 2: "Why don't WEEE recycle?" - How psychology contributes to improve e-waste management

Despite the risks that e-waste poses to human and environmental health, many consumers remain hesitant to discard outdated products or to dispose of e-waste through formal collection systems (Borthakur & Singh, 2020). The acknowledgement of this issue in recent years has brought the concept of circular economy to gain more and more importance in tackling the e-waste issue. Circular economy refers to "an industrial system that is restorative or regenerative by design and intention" (Ellen MacArthur Foundation, 2013), seeking to eliminate waste by optimizing product and material cycles while maintaining their highest value and utility (Ellen MacArthur Foundation, 2015). This approach utilizes innovative business models, supportive policies, and renewable technologies, (Ghisellini et al., 2016). While the starting point for appropriate e-waste recycling in a circular economy model is always consumer behaviour (e.g., Parajuly et al., 2020; Islam et al., 2021; Thukral et al., 2023), other key players include governments, policymakers, charitable organizations, private sector investors, digital innovators (both multinational and entrepreneurial), product manufacturers, component suppliers, service providers, and stakeholders in the recycling industry (Ellen MacArthur Foundation, 2015). These actors, along with various elements and factors, interact in a complex manner, requiring a transdisciplinary approach to fully understand e-waste recycling behaviours and implement effective intervention strategies (Alamerew & Brissaud, 2020).

Despite the importance of consumers for e-waste management success, academic discussions on environmental sustainability often overlook the consumption phase of the product lifecycle compared to the production phase. In the consumption phase, e-products go through 4 main stages: 1) inactive EEE, 2) critical moment, 3) transition from EEE to WEEE, and 4) divestment (Casey et al., 2019). Most carbon management frameworks focus on production-based accounting rather than consumption-based (Sudmant et al., 2018). The latter approach attributes emissions to the point of

consumption of goods and services, which may offer better insights for climate policies (Steininger et al., 2014). This trend is understandable given the "linear" nature of current economic systems, where production, consumption, and end-of-life management of consumer goods are largely treated as separate processes. In a circular economy, the emphasis shifts to the consumption (or use) of products, with the goal of maximizing the utility and lifespan of resources (Ellen MacArthur Foundation, 2013). While recent years have seen extensive study of the techno-economic dimensions of the circular economy, the role, motivations, and behaviours of end users in a circular system have not received equal attention, gaining interest in the psychological field only in recent years (e.g., Parajuly et al., 2020; Islam et al., 2021; Gilal et al., 2022; Thukral et al., 2023).

4.1. Theories to understand e-waste disposal behaviour

Parajuly and colleagues (2020) conducted a literature review of existing behavioural and economic theories and their application in the context of e-waste pro-environmental behaviours. The authors identified more than 80 theories used across the field of psychology and behavioural change. Although most common theories of pro-environmental behaviours may be categorised as moral or rational choice models (Turaga et al., 2010), the literature is overall fragmented. Recent reviews identified more than 11 psychological variables that may affect e-waste recycling behaviours, stemming from only 6 of the most common theories used in research on e-waste disposal behaviour (Thukral et al., 2023). Currently, there is no consensus on which variable weighs more when affecting e-waste recycling behaviours (Parajuly et al., 2020). The following sections briefly explore these theories and models.

4.1.1. Theory of Reasoned Action

Fishbein and Ajzen (1977) introduced the idea of predicting human behaviour based on pre-existing attitudes and intentions. The Theory of Reasoned Action (TRA) focuses on theoretical constructs related to a person's motivational factors as determinants of the likelihood of carrying out a behaviour. TRA suggests that behaviour is a cognitive process wherein a person can choose whether

to perform a specific behaviour or not. The theory posits that a consumer's intention to perform a behaviour is governed by their attitude toward the behaviour and subjective norms. Attitude toward the behaviour reflects whether a person has a favourable or unfavourable opinion of the behaviour based on their experience and beliefs. Subjective norms represent the perceived social pressure to perform or not perform the behaviour. This theory has been widely applied in behavioural studies to examine communication, health, and consumer behaviour (Singh et al., 1995; Yousafzai et al., 2010). In the e-waste recycling literature, a few authors (Colesca et al., 2014; Gonul et al., 2016; Nwagwu & Williams, 2016) have implemented TRA to examine household participation in e-waste recycling.

4.1.2. Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is a widely used psychological theory in the study of pro-environmental behaviour (Botetzagias et al., 2015). TPB centres on an individual's "intention" to perform a specific behaviour, suggesting that such intentions can be predicted by attitudes toward the behaviour, subjective (social) norms, and perceived behavioural control. The actual behaviour results from these intentions, combined with an individual's perception of their ability to perform the behaviour (Ajzen, 1991). Assuming that intention is viewed as the most critical factor in behavioural change, the TPB framework supports 'goal-directed' interventions to foster pro-environmental intentions and, subsequently, behaviours (Botetzagias et al., 2015). TPB has been increasingly used in e-waste recycling literature to elucidate factors influencing consumers' intentions toward electronic waste (Tonglet et al., 2004; Wang et al., 2016; Echegaray and Hansstein, 2017; Fan et al., 2022; Ylä-Mella et al., 2015; Borathakur and Govind, 2018; Liu et al., 2019; Kumar, 2019; Najmi et al., 2020; Aboelmaged, 2021).

4.1.3. Value-belief-norm theory

The Value-Belief-Norm Theory (VBNT) of environmentalism, proposed by Stern et al. (1999), focuses on moral values and norms to explain individual behaviour related to environmental concerns. According to this theory, "pro-environmental behaviours stem from the acceptance of particular

personal values, from beliefs that things important to those values are under threat, and from beliefs that actions initiated by the individual can help alleviate the threat and restore the values" (Stern et al., 1999). In the context of e-waste research, studies by Sari and colleagues (2021) and Ylä-Mella and colleagues (2015) have combined VBNT with the TPB to better understand consumers' intentions to dispose of their household e-waste.

4.1.4. Behavioural Reasoning Theory

The theory introduced by Westaby (2005) posits that reasons serve as crucial links between beliefs, broader motivations (such as attitudes, social norms, and perceived control), intentions, and behaviour. Known as Behavioural Reasoning Theory (BRT), this theoretical framework enables psychologists and researchers to analyse the relative influence of both positive and negative reasons behind intentions towards innovations. It allows practitioners to evaluate how various attributes impact consumers' intentions and behaviours within a unified decision-making framework (Sahu et al., 2021). Consequently, BRT has been applied across diverse fields including clothing (Diddi et al., 2019), sustainable transportation (Peterson & Simkins, 2019), mobile banking (Gupta & Arora, 2017), renewable energy (Claudy et al., 2013), and organic food (Ryan & Casidy, 2018). Recently, Dhir and colleagues (2020) utilized BRT in recycling research to predict the attitudes and intentions of Japanese consumers regarding e-waste disposal.

Summing up, there are many theories with which e-waste recycling behavioural studies have been framed. However, the outcomes of these studies, primarily based on questionnaire surveys, show mixed results. Some findings indicate that environmental awareness is the most significant predictor of e-waste recycling intentions (Wang et al., 2016), while others emphasize social norms (Echegaray & Hansstein, 2017), attitude (Kumar, 2019), and perceived behavioural control (Le et al., 2013) This suggests that external factors, such as demographic and socioeconomic variables, as well as situational factors like convenience, might indirectly influence e-waste recycling behaviour, potentially challenging the broad applicability of these theories. Moreover, the well-documented "intention-behaviour gap" — the discrepancy between intentions and actual behaviours—raises

further scepticism about the effectiveness of behavioural change interventions based on theoretical models only (Michie et al., 2009).

4.2. The intentions-behaviour gap for e-waste management practices

Apart from investigating the antecedents of e-waste recycling intentions and behaviours, all the theories have an important gap in common, called the "intentions-behaviours gap". There is in fact a discrepancy between e-waste disposal intentions and e-waste disposal behaviour. A meta-analysis conducted by Sheeran (2002) indicated that, on average, intentions can only explain 28% of the variance in future behaviour, and a survey from Echegaray and Hansstein (2017) showed that most respondents had a positive intention toward e-waste recycling, despite only 6% of them recycling WEEE. Most Europeans acknowledge the environmental challenges linked to consumption patterns and understand the significance of effective resource utilization (European Union, 2014). Many also report engaging in waste sorting and show openness to adopting reused items or alternative business models like leasing (Cerulli-Harms et al., 2018). However, actual practices often do not align with these claims.

The intentions-behaviours gap currently is an important issue for ensuring the implementation of e-waste management practices. In fact, end-users of e-products (consumers) play a crucial role in the three crucial steps of a product lifecycle: purchase, use, and end-of-life (EoL) management. Their decisions and behaviours during these stages significantly impact the effectiveness of circular economy strategies such as reuse, repair, and recycling. Consumer actions such as investing in durable products, engaging with circular business models, opting for repair and reuse, and ensuring proper disposal at EoL are essential for resource recovery. The success of circular strategies, aimed at enhancing resource efficiency, depends on public acceptance and adaptation. Technological and economic challenges exist in creating an ideal system for circular economy engagement, but user behaviours, driven by incentives and legislation, play a critical role in EoL collection, resource recovery, and overall circular system success for e-products (Parajuly et al., 2020).

Figure 4 provides examples of the discrepancy between people's statements and their actions regarding the purchase, use, and end-of-life (EoL) of electronic products. Although based on limited data and not all directly comparable, these examples offer valuable insights. For instance, while 76% of Europeans claim to sort their e-waste, only 35% of generated e-waste is collected through official channels in the EU. This suggests that a portion of sorted e-waste is either stockpiled at home or collected via unofficial means. Recent research (Unitar, 2022) reveals that the average household in the EU has about 74 electrical and electronic devices (excluding lamps and luminaires), totalling approximately 90 billion kilograms in weight. Of these, 61 devices are currently in use, while an estimated 4 devices per household are non-working and stored, awaiting disposal. This amounts to roughly 3 billion kilograms of discarded appliances that could either be repaired or sent to WEEE collection programs. Proper persuasion or incentives for consumers could greatly enhance collection rates (Unitar, 2024).

This “intention-behaviour” gap results not only from consumer choices but also from the availability of e-waste disposal options and collection systems, which are often beyond consumers' control (Parajuly et al., 2020). In fact, some authors argue that the intentions-behaviour gap depends on environmental variables such as accessibility to collection centres (Zhang, et al., 2019) incentive measures (Wang et al., 2019), and convenience (Cheng et al., 2020). Nevertheless, while psychological motivators are extensively investigated, there are only a few studies that consider environmental variables such as the convenience of e-waste collecting services as influencing WEEE recycling behaviours. This proclivity to overlook situational factors aligns with European legislation, where limited efforts are made to facilitate the return of electronic equipment through a swift, user-friendly process. In contrast to other waste streams like packaging, biomass, or paper, which offer simpler disposal methods, e-waste requires consumers to navigate a more intricate network of collection points managed by municipalities and retailers. Despite this complexity, the deployment of e-waste collection containers for smaller devices is slowly expanding across the European Union, although it remains limited in scope (Unitar, 2024).

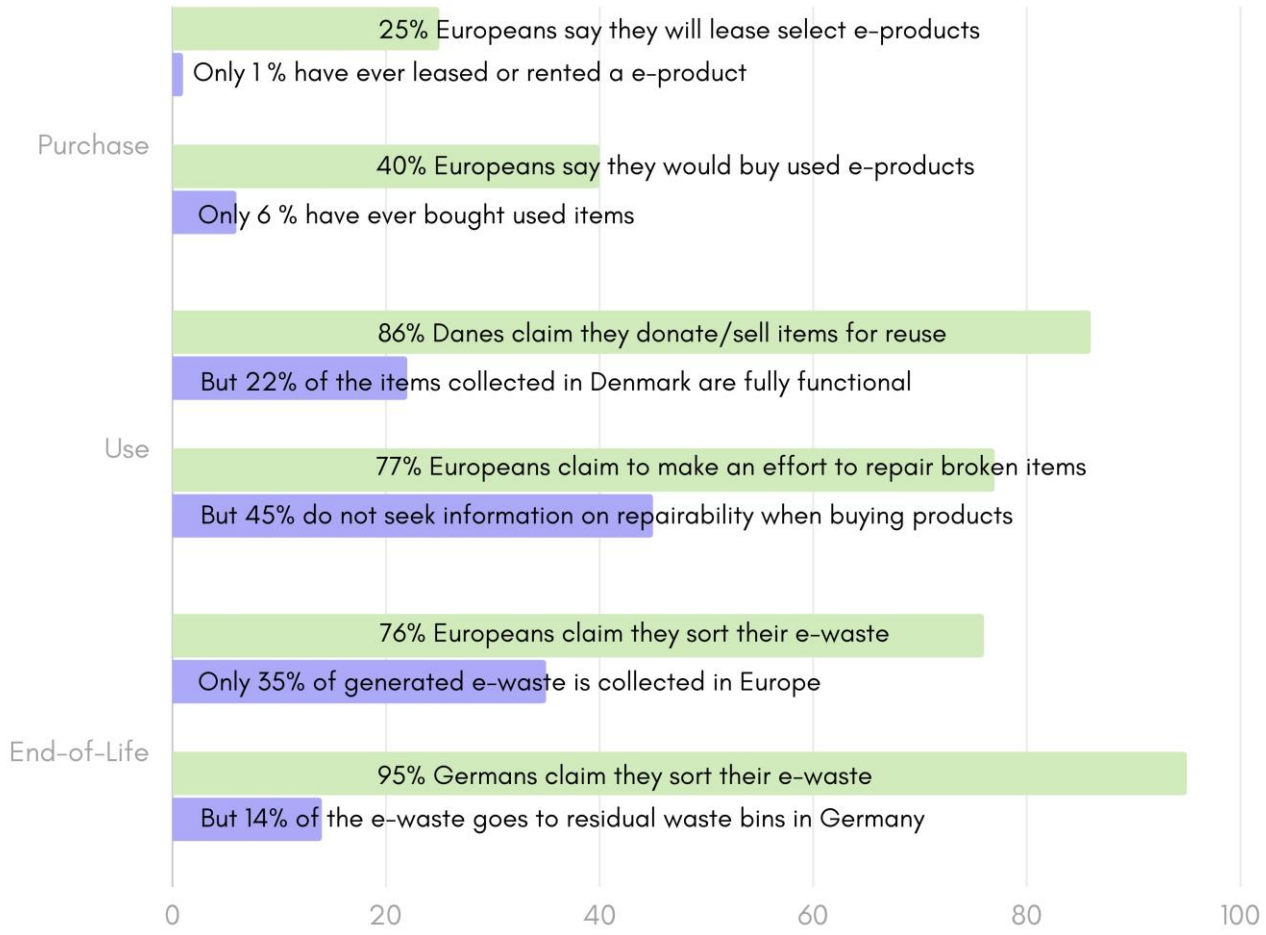

Figure 4. Discrepancy between people's statements and e-waste recycling behaviours, adapted from Parajuly and colleagues (2020)

4.3. Designing innovative solutions to enhance e-waste management: nudging applied to e-waste management

Many environmental issues are rooted in human behaviour, necessitating behavioural changes to harness the potential of technological innovations for environmental sustainability (Steg & Vlek, 2009). Intervention strategies promoting pro-environmental behaviour through information campaigns are often limited in effectiveness because environmental literacy does not always lead to sustainable actions (Frisk & Larson, 2011). In fact, human behaviour is influenced by both intrinsic and extrinsic factors (Martin et al., 2017). In the realm of sustainable consumption, intrinsic factors encompass beliefs, knowledge, motivation, attitudes, habits, values, intentions, and other psychological variables. Conversely, extrinsic factors include social and cultural norms, financial

considerations, and contextual elements such as infrastructure, convenience and institutional constraints (Faiers et al., 2007).

One of these behavioural changing techniques is nudging. Nudging originated from behavioural economics, which, unlike traditional economic theories, posits that: a) material incentives are not the sole drivers of human behaviour; b) social norms and contextual factors have a substantial impact; and c) cognitive limitations can result in biased decision-making (Carlsson & Johansson-Stenman, 2012). Nudging operates on the premise that humans do not always make decisions based solely on their knowledge and intentions, as their decision-making is frequently swayed by heuristics (Thaler & Sunstein, 2009). This poses a challenge to behavioural change frameworks that rely on the assumption of utility maximization (e.g., economic incentives). To address this, behavioural economists have introduced two concepts: choice architecture and libertarian paternalism (Sunstein, 2015). A "nudge" leverages on the concept of libertarian paternalism (i.e., an approach to behavioural economics that preserve freedom of choice while steering people in a particular direction) to help individuals make better choices without coercion, gently guiding them towards the "right choice" (Sunstein, 2015). Unlike other methods that aim to completely change behaviour, nudges thus use subtle cues to influence how people act without them even realizing it (Leonard, 2008). For example, Schmidtke and colleagues (2019) investigated and found that changing the order of the soft drinks in a café increased the sales of no sugar soft drinks, as they were shown first in the touchscreen kiosks interfaces, decreasing the sugary soft drinks consumption. McCoy and colleagues (2018) found that relocating recycling trash bins in popular locations of a university campus significantly increased diversion rates.

Nudges have thus been tested and found effective in various contexts, such as reducing food waste (Kallbekken & Sælen, 2013), decreasing plastic waste (Rivers et al., 2017), and promoting the adoption of more expensive green energy (Ebeling & Lotz, 2015). In the realm of e-products, research has explored using nudges to promote the repair, leasing, and purchase of "greener" mobile phones (Stefansdotter et al., 2016). While experimental trials based on simulated scenarios have shown

promising results for these nudges, their effectiveness in real-world applications remains uncertain (Parajuly et al., 2020).

As a matter of fact, the process of designing effective nudges may be expensive in terms of implementation time. Nudges are inherently context-specific, and not all strategies are equally effective for influencing specific behaviours. For example, Momsen and Stoerk (2014) conducted a survey experiment to explore how different types of nudges affected the choice whether to contract renewable or conventional energy. Their findings showed that default cues (i.,e., showing "renewable" as the pre-selected option) are the only effective nudge, while the others (i.e., priming, social norms, decoy, framing, and mental accounting) have little or even negative impact. Summing up, implementing nudges can be complicated and research should focus on exploring their effectiveness in different environments. A thorough methodological approach is required to develop the appropriate nudging strategy and applying it in a context where it can thrive.

Digital nudging may be another important context-specific solution: while nudges act in the physical environment, digital nudges rely on subtle cues and digital choice architecture within the user interface to influence people's decisions – without them even noticing it (Parajuly et al., 2020). Each of these cues leverages on a specific bias: for instance, the "scarcity effect" bias posits that people tend to choose a less available product when they have the chance. One way to translate this bias into a digital nudge is to display a pop-up claim that informs the user on the low availability of the desired product. Pop-up claims can also translate the "social norms" bias by displaying a high number of people choosing that product (Schneider et al., 2018). In this digital context, an important attribute to consider when implementing nudges is the time of application. "During action" nudges (i.e., nudges that appear when the participant makes a decision) are proven to be effective in some applications (e.g., Berger et al., 2020; Folkvord et al., 2020). However, time of application is still not taken thoroughly into account when conducting e-waste research, as "after action" nudges (i.e., nudges that appear once a participant has made a decision) are still neglected by psychological research (e.g., Berger et al., 2022). To summarise, nudges have been reported to be effective in promoting pro-

environmental behaviour (Wee et al., 2021), with scarce digital nudging study attempts focusing on e-waste (e.g., Stefandotter et al., 2016).

4.4. Thesis Aims, Research Questions and Studies outline

As previously mentioned, psychological research is crucial to investigate consumers' intentions and behaviours regarding e-waste management, ultimately minimising the impact that the e-waste crisis is having on the environment, human health, and economy. Nevertheless, psychological literature on this topic currently displays three main gaps. On one hand, despite the plethora of studies using different theories to explore psychological antecedents of e-waste recycling intentions and behaviour, there is no consensus on which factors have stronger effect-sizes and, thus, are more likely to influence this type of disposal behaviour (e.g., Parajuly et al., 2020; Thukral et al., 2023). Moreover, there are few studies that focus on the influence of external, situational factors on e-waste recycling behaviours, this proclivity enlarging the intentions-behaviour gap for e-waste management practices (Parajuly et al., 2020). Finally, the literature on WEEE recycling behaviours struggles to develop viable, fast and feasible practical implications for organizations, with scarce attempts to design and test innovative digital nudging solutions to engage consumers in e-waste recycling (Dhir et al., 2021; Stefandotter et al., 2016).

Therefore, in collaboration with a multi-service company located in the Emilia-Romagna region of Italy, the present PhD project has three main aims.

1) To achieve a more solid knowledge of the relationship between the various constructs predicting WEEE recycling intentions and behaviours by means of a meta-analysis focused on e-waste (*Study 1)*.
2) To clarify the role of environmental variables (i.e. collection centres convenience) in affecting e-waste recycling behaviours, thus contributing to bridge the intentions-behaviour gap (*Study 2*).

3) To experimentally test the effectiveness of digital nudging on e-waste reuse and e-waste recycling intentions and behaviours, ultimately to propose innovative solutions to improve e-waste management practices (*Study 3).*

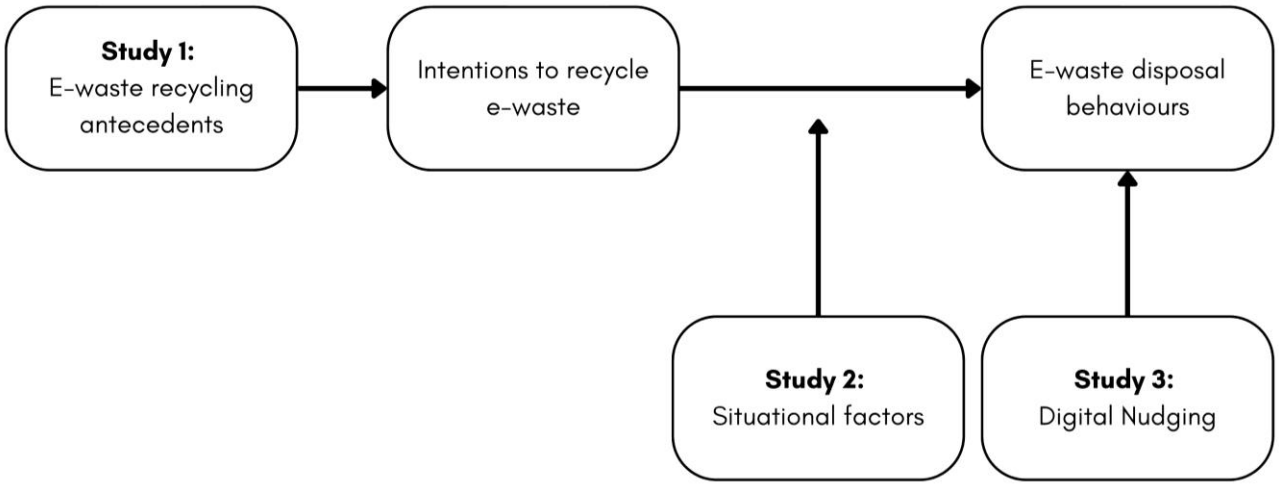

Figure 5. Conceptual map of PhD project aims and corresponding studies.

5. Chapter 3: Reaching an agreement on psychological antecedents of e-waste recycling intentions and behaviours (Study 1)

Puzzo, G., & Prati, G. (2024). Psychological correlates of e-waste recycling intentions and behaviors: A meta-analysis. *Resources Conservation and Recycling*, *204*, 107462. https://doi.org/10.1016/j.resconrec.2024.107462

5.1. Introduction

As mentioned in chapter 1, e-waste poses a severe challenge to sustainability owing to its massive waste stream (Qalati et al., 2021) and to the numerous toxic substances it contains (Owusu-Sekyere et al., 2022; Zhao et al., 2023). E-waste management is thus crucial for achieving both resource efficiency and environmental sustainability (Unitar, 2024). Consumers are the crucial starting point for successful e-waste management, as they are the ones to dispose of e-waste and determine its destination (Islam et al., 2021). It is, thus, paramount to identify the psychological correlates of consumers' e-waste recycling intentions and behaviours to trigger a change in users' choices regarding recycling, ultimately developing management practices that reduce the environmental impact of e-waste (Saphores et al., 2012).

Since the 2000s, many studies have investigated the psychological correlates of e-waste recycling intentions and behaviours (Parajuly et al., 2020). While these studies have hugely expanded knowledge on this topic, the high number of studies led to fragmentation of the literature. Parajuly and colleagues (2020) reviewed more than 80 theories adopted in the field of behavioural change and found no consensus on the strength of each variable when influencing intentions and behaviours. Researchers across different academic fields have identified many entry points for interventions (Islam et al., 2021); however, there is currently no meta-analytical review of the most important factors that may influence consumers' decisions.

To bridge these gaps, the first study of this thesis aims to conduct a global meta-analysis to determine the strength of the relationships between key theory-based psychological factors and people's e-waste recycling intentions and behaviours. To justify the analysis of each hypothesized relationship, we have reviewed the most established theories in the literature on antecedents of intentions and

behaviours: the theory of planned behaviour (Ajzen, 1991), the value-belief-norm theory (Stern, 2000), habit theories (Verplanken and Aarts, 1999), and behavioural reasoning theory (Westaby, 2005). While we do not aim to compare them nor to test a general model, we argue that these theories are potentially complementary - in the sense that they can enrich and benefit from one another. This transtheoretical view will help define future research and practice, as we will identify the most critical psychological correlates of intentions and behaviours across different theories. Our meta-analytic study will inform researchers about the key research questions for future research. Moreover, our findings will be useful for practitioners and policymakers, as we will identify the most important psychological factors they may consider when strategically developing effective e-waste management practices.

5.2. Theoretical Background

5.2.1. The Theory of Planned Behaviour

One of the most widely used psychological theories for investigating recycling intentions and behaviours is the theory of planned behaviour (Parajuly et al., 2020). The theory of planned behaviour posits that planning and forming an intention to act are related to performing the related behaviour. Intentions are, in turn, influenced by three factors (Ajzen, 1991). Attitudes refer to how positively or negatively a person evaluates the behaviour. Subjective norms are perceived social pressures to perform or avoid the behaviour. Finally, perceived behavioural control refers to how easy or difficult the behavioural performance is perceived to be. Therefore, we hypothesize as follows:

H1: Intentions to recycle e-waste will positively correlate with behaviours.

H2: Attitudes will positively correlate with intentions to recycle e-waste.

H3: Subjective norms will positively correlate with intentions to recycle e-waste.

H4: Perceived behavioural control will positively correlate with intentions to recycle e-waste.

The theory of planned behaviour has been extensively adopted to frame e-waste recycling studies, including other relevant psychological variables (Parajuly et al., 2020) such as environmental knowledge. Hines and colleagues (1986) define environmental knowledge as those cognitive factors pertaining to knowledge of an environmental issue (i.e., the consequences of an environmental problem or how to act on a specific challenge). Based on their results, the authors argue that intentions are the consequence of cognitive-related variables. Before an individual can intentionally act on a particular environmental problem, that individual must know of the existence of the problem. Knowledge appears to be a prerequisite for intentions to act; consequently, some extended versions of the theory of planned behaviour also include knowledge as an antecedent of intentions (Kochan et al., 2016; Kumar, 2019). Recent research found that knowledge of e-waste recycling and its consequences is significantly related to intentions (Koshta et al., 2022; Najmi et al., 2020). Thus, we hypothesize as follows:

H5: Environmental knowledge will positively correlate with intentions to recycle e-waste.

Ajzen (1991) also suggests that behaviours may depend on situational or external factors in terms of time, money availability, storage space, or access to recycling schemes (Kuhl and Beckmann, 2012). Convenience is a construct that reflects an individual's perceived time availability and ease in managing e-waste (Tonglet et al., 2004) and has been found to positively influence intentions (Kochan et al., 2016). Convenience was significantly associated with perceived behavioural control, as time availability and ease of performing e-waste recycling may shape the perception of the difficulty of the same task (Cheng et al., 2020; Mahmud et al., 2020). A recent cross-sectional study examining intentions and behaviours in a sample of 110 people in Malaysia revealed a significant relationship between convenience and e-waste recycling intentions (Shaharudin et al., 2020). We hypothesize that:

H6: Convenience will positively correlate with intentions to recycle e-waste.

Policy effectiveness (i.e., the government's perceived capability to satisfactorily implement e-waste recycling policies) is another important situational factor affecting e-waste recycling intentions (Wan

et al., 2014). Prior studies have focused on delineating the policy implications for promoting recycling behavior. Steg and Vlek (2009) underscored policy strategies for altering attitudes, addressing social norms, and facilitating pro-environmental behaviour. Another stream of research investigated how perceptions of policy effectiveness motivate people to perform recycling behaviours. Wan and Shen (2013) posited that if a government-initiated motivational policy is perceived as more effective, it is likely to increase the intention to act. In line with this argument, Shaharudin and colleagues (2020) found that policy effectiveness was positively related to intentions to recycle e-waste. Therefore, we hypothesize that:

H7: Policy effectiveness will positively correlate with intentions to recycle e-waste.

Relevant external variables include economic benefits and costs associated with recycling activities (Wang et al., 2019). Lan and Zhu (2009) explored how economic incentives encourage users to dispose of household appliances. They found that the transparent pricing of online recycling platforms could significantly impact residents' inclination to recycle. Moreover, Wang and colleagues (2011) examined residents in Beijing and established that as economic costs increase, the intention to recycle e-waste weakens. More recently, in two studies conducted in China, Wang and colleagues (2016; 2019) hypothesized that intentions might be shaped by the economic benefits and costs of e-waste recycling. Their findings provide partial support to their hypothesis, showing that economic costs were negatively related to intentions (Wang et al., 2016). Intentions were found to be positively associated with economic benefits as well (Wang et al., 2019). We therefore hypothesize that:

H8: Economic benefits will positively correlate with intentions to recycle e-waste.

H9: Economic costs will negatively correlate with intentions to recycle e-waste.

5.2.2. Value-Belief-Norm Theory

One of the theories used to frame intentions and behaviours is the norm-activation theory (Schwartz and Howard, 1981). One assumption of the norm-activation theory is that people help each other if they feel morally obliged to do so by a personal norm. Stern (2000) organized the identified variables

in causal order, giving birth to the value-belief-norm theory. Stern assumes that individuals' behaviours are directly determined by their personal norms, which are activated by the ascription of responsibility (i.e., the degree to which individuals accept responsibility for their actions) and, in turn, by awareness of consequences (i.e., the degree to which individuals understand the consequences of their behaviour). Empirical evidence supports the application of value-belief-norm theory in the environmental domain (e.g., De Groot and Steg, 2007; Hansla et al., 2008). However, the number and scope of examples from the e-waste domain are limited (e.g., Parajuly et al., 2020; Saphores et al., 2012). Therefore, we hypothesize that:

H10: Personal norms will positively correlate with intentions to recycle e-waste.

5.2.3. Habit Theories

Habits are automatic responses to specific stable situations that are functional in achieving goals. They develop both by frequently repeating the same behaviour in the same situation and by being rewarded for achieving the desired goals (Verplanken and Aarts, 1999). The more frequently a behaviour is performed, the more established the habit becomes. A habit can be related to the degree of automaticity a behaviour has in each situation (Klockner, 2013). Both Triandis (1980) and Ajzen (1991) argue that, once a habit is established, the corresponding behaviour occurs to some extent independently of the influence of attitudes, subjective norms, perceived behavioural control, and intentions.

While the importance of routine actions calls for fundamentally different psychological models that consider the transition toward the circular economy (Parajuly et al., 2020), habits are usually included as a determinant of pro-environmental intentions. Klockner and colleagues (2013) conducted a meta-analysis of 53 studies investigating several types of pro-environmental intentions (i.e., car use, waste behaviour, energy behaviour, and food-related behaviour). Their results show that habits play an important role in predicting behaviour. Regarding the specific case of e-waste, Wang and colleagues (2011) define recycling habits as one of the most important factors pushing people to use appropriate

recovery channels for e-waste. Habits have also been included in many reviews (Dhir et al., 2021b; Islam et al., 2021; Parajuly et al., 2020) as some of the most influential factors on intentions. Therefore, we hypothesize that:

H11: Habits will positively correlate with intentions to recycle e-waste.

5.2.4. Behavioural Reasoning Theory

The behavioural reasoning theory is a theoretical framework that assesses the relative influence of both the perceived benefits ("reasons for") and the perceived risks ("reasons against") in the relationship between the environmental values held by individuals, their attitudes, and their intentions (Westaby, 2005; Sahu et al., 2020). On one hand, perceived benefits ("reasons for") are reflected by personal and environmental benefits that individuals can obtain when recycling e-waste (Botelho et al., 2016). Personal benefits refer to non-economic gains accrued to consumers if they recycle e-waste, such as the reduced health hazard that consumers may experience (Dhir et al., 2021a), while environmental benefits refer to the improvement of energy conservation, reduction in pollution, and the extended life of the product (Baxter et al., 2016).

On the other hand, perceived risks ("reasons against") are resistors that can cause negative perceptions of performing a specific behaviour (Sahu et al., 2020). "Reasons against" are operationalized as being made of four different types of barriers to engagement in a task (e.g., Dhir et al., 2021a; Nyeko et al., 2022). Risk barriers reflect the different risks perceived by the consumer in a particular activity (Kaur et al., 2020). Value barriers are mostly associated with the perceived monetary value gained — or lost — by the consumer (Talwar et al., 2020), usage barriers are defined as the inconvenience of practicing or adopting innovation (Lian and Yen, 2014), while image barriers arise when consumers possess negative perceptions about a product (Kaur et al., 2020; Lian and Yen, 2014; Talwar et al., 2020).

Recently, researchers have conducted studies on benefits and risks of e-waste recycling intentions. Dhir and colleagues (2021a) explored how "reasons against" (i.e., perceived risks) and "reasons for"

(i.e., perceived benefits) influence intentions. Their results highlighted the impact of both benefits and risks on e-waste recycling intentions. Nyeko and colleagues (2022) hypothesized that perceived benefits and risks influence e-waste disposal intentions. Their results show how perceived benefits positively influence intentions, while perceived risks negatively affect them. We thus hypothesize that:

H12: Perceived benefits will positively correlate with intentions to recycle e-waste;

H13: Perceived risks will negatively correlate with intentions to recycle e-waste.

5.2.5 The Present Study

The aim of the present study was to determine the strength of the relationships between key theory-based psychological factors and e-waste recycling intentions and behaviours. Drawing from the background provided above, we have identified theoretical support for each hypothesized correlational relationship. Specifically, the purpose of the present research is to synthesize quantitative research that applies the extended theory of planned behaviour, value-belief-norm theory, habit theories, and behavioural reasoning theory. While we did not aim to compare these theories or to test a general model, we strongly believe that understanding the strength of every relationship across studies framed within different theories will contribute to an improvement of future research and practices. Although these theories do not make strong predictions about moderators of the hypothesized relationships between model constructs, we also aimed to investigate the potential effects of four moderators (i.e., age, gender, region of data collection, and study quality) on the relationships between the considered variables.

5.3. Materials and Methods

5.3.1. Identification of relevant research studies

We based this meta-analytic work on three search criteria:

(1) The study should aim to investigate a relationship between at least one psychological variable and e-waste recycling intentions and/or behaviors.

(2) The study should use operationalizations in line with standardized measures or indications by the authors.

(3) The study should report the correlation coefficients or other statistics that could be converted to effect size *r* (e.g., effect size *d*, beta path coefficients*)* and the number of participants.

The literature search strategies were developed using text words related to the literature on intentions and behaviours. To maximize the validity of the meta-analysis and diminish the effect of publication bias, both published and unpublished studies (e.g., grey literature) were searched. Studies that could not be accessed were obtained by contacting their authors via e-mail or on social media. The observational study quality evaluation (Drukker et al., 2021) was used as a quality assessment tool. The search was conducted in three databases (Scopus, Web of Science, and Google Scholar) and included studies in the English language. The specific search strategies were created by the two authors sequentially, with one person developing the search strategies that were reviewed by the other member of the research dyad. The search strategies, search terms, and criteria used are provided in Appendix A, B, and C for Scopus, Google Scholar, and Web of Science respectively.

Literature search results (e.g., title, authors, year of publication, and abstract) were screened by the two authors. Before the screening process, the authors removed duplicate studies and non-English ones. The two authors independently screened titles, authors, year of publication, and abstracts to decide which study to include. The resulting estimate of inter-rater reliability using Cohen's kappa was 0.71 (95% CI [.64, .78]). According to the guidelines provided by Landis and Koch (1977), this value indicates substantial agreement. Consequently, full-text articles were obtained for all included titles and abstracts (n= 104), and researchers decided whether they were eligible according to the inclusion criteria after thoroughly reading them. Where necessary, the researchers sought additional

information and full-text reports from the original study authors, ultimately resolving questions about eligibility. The reasons for eventually excluding the studies were recorded.

5.3.2. Data extraction and labelling process

Each eligible study included correlations (Pearson's r) or standardized path coefficients between at least a psychological variable and e-waste recycling intentions or behaviors, as well as the number of participants. The two authors extracted data from each eligible study including study title, year of publication, source title, summary of the results, continent, whether the journal is a peer-reviewed one, whether the study was longitudinal, average age and percentage of women, independent and dependent variables, reliability scores, and correlation coefficients. The total number of longitudinal studies was not sufficient to undertake any comparison with cross-sectional articles (Liu et al., 2012; Kumar, 2019). For these two cases, we reported only cross-sectional data stemming from the latest data-collection time point. Moreover, the article authored by Kumar (2019) reported separately the results of two datasets stemming from a Chinese and an Indian sample, respectively. In this case, we have decided to consider the reported coefficients separately for the meta-analysis- as if they belonged to two different studies.

Regarding reliability scores, some articles generally reported that they were higher than a fixed value. In these cases, we retained the fixed value reported in the study as the reliability score. Standardized beta path coefficients stemming from structural equation modeling or hierarchical regression analyses were converted into Pearson's r according to Peterson and Brown (2005). The formula developed by the authors can only be used for beta coefficients included between -.05 and .05; therefore, we excluded coefficients that did not fall within this range. One study (Echegaray & Hannstein, 2017) provided only odds ratio coefficients stemming from multiple logistic regression analysis, and it was thus excluded from the analysis.

The authors acknowledge the difficulty of including every extracted variable in the data analysis, given the large number of constructs measured in the 38 studies. To facilitate the data analysis phase,

the authors retained the constructs that were investigated in at least three studies. Two studies (Gilal et al., 2019; Fan et al., 2022) were removed because they investigated only constructs that did not meet this criterion.

It is necessary to underline that every study was written by a different research team and that a taxonomy on psychological antecedents of e-waste recycling intentions and behaviors is currently missing, giving rise to a high number of variable labels and operationalizations for the same construct. To reduce the impact of this risk, the authors checked the definition and scale items of every retained variable and decided on a common label to assign them. Two or more different labels belonging to different studies were integrated into one if: 1) the authors extracted the corresponding scales from the same original study or theoretical framework; 2) labels had the same operationalization or items; 3) labels shared the same theoretical definition. The authors of the present study resolved disagreements through discussion.

According to these criteria, we encountered different variables that measured the same construct (e.g., Delcea et al., 2020). We found that the items pertaining to social norms and social influence were comparable to the ones of subjective norms in other studies (e.g., Koshta et al., 2022), while the items of "government measures" and "government and NGOs" both referred to "perceived policy effectiveness" (e.g., Shaharudin et al., 2020). For these reasons, we integrated "social norms" and "social influence" into "subjective norms", and "government measures" and "government and NGOs" into "policy effectiveness." The article authored by Nyeko and colleagues (2022) analyzes separately the effects of personal benefits, environmental benefits, value barrier, risk barrier, image barrier, and usage barrier on e-waste recycling attitudes and intentions. In this case, we followed the operationalization provided by Dhir and colleagues (2021) and we integrated personal and environmental benefits into perceived benefits, while value, risk, image, and usage barriers were integrated into perceived risks. Every variable integration was done by using the aggregate function in the R package metafor (Viechtbauer, 2010). The same article (Nyeko et al., 2022) included two operationalizations of e-waste recycling intentions: collection intentions (reflecting the behavior of

bringing e-waste to the collection center) and disposal intentions (encompassing both the behavior of bringing e-waste to collection centers as well as the behavior of calling multi-service company to deal with e-waste stored at home). In this case, we decided to only consider disposal intentions, as it encompasses more types of behavioral intentions to recycle e-waste.

Double-barreled variables (i.e., that measured two different constructs) were excluded from the analyses. Nguyen and colleagues (2018) measured both attitudes and environmental awareness on the same scale ("attitudes and environmental awareness"); Mouton (2020) measured both social norms and publicity on one scale ("norms and publicity"); therefore, these variables were removed by both articles. Finally, we detected a proclivity to arbitrarily adopt the labels of "awareness of consequences" or "environmental knowledge" independently from the theoretical framework (e.g., Koshta et al. 2022; Kumar, 2019) they refer to. For instance, Kochan and colleagues (2016) analyzed the relationship between "awareness of consequences" and e-waste recycling intentions even though this is not envisaged by the NAM nor VBN theory. Both awareness of consequences and environmental knowledge refer to cognitive factors pertaining to knowledge of the environment or the consequences of an environmental problem (Aung & Arias, 2006; Hines et al., 1986; Schwartz & Howard, 1981). Given the similarity that these two constructs share both in their definition and their operationalization, we have decided to name these variables as "awareness of consequences" only for studies framed within the VBN and as "environmental knowledge" for those within the extended TPB. Each retained variable, the theoretical definition, sample items, and the theory of reference are available in Appendix D.

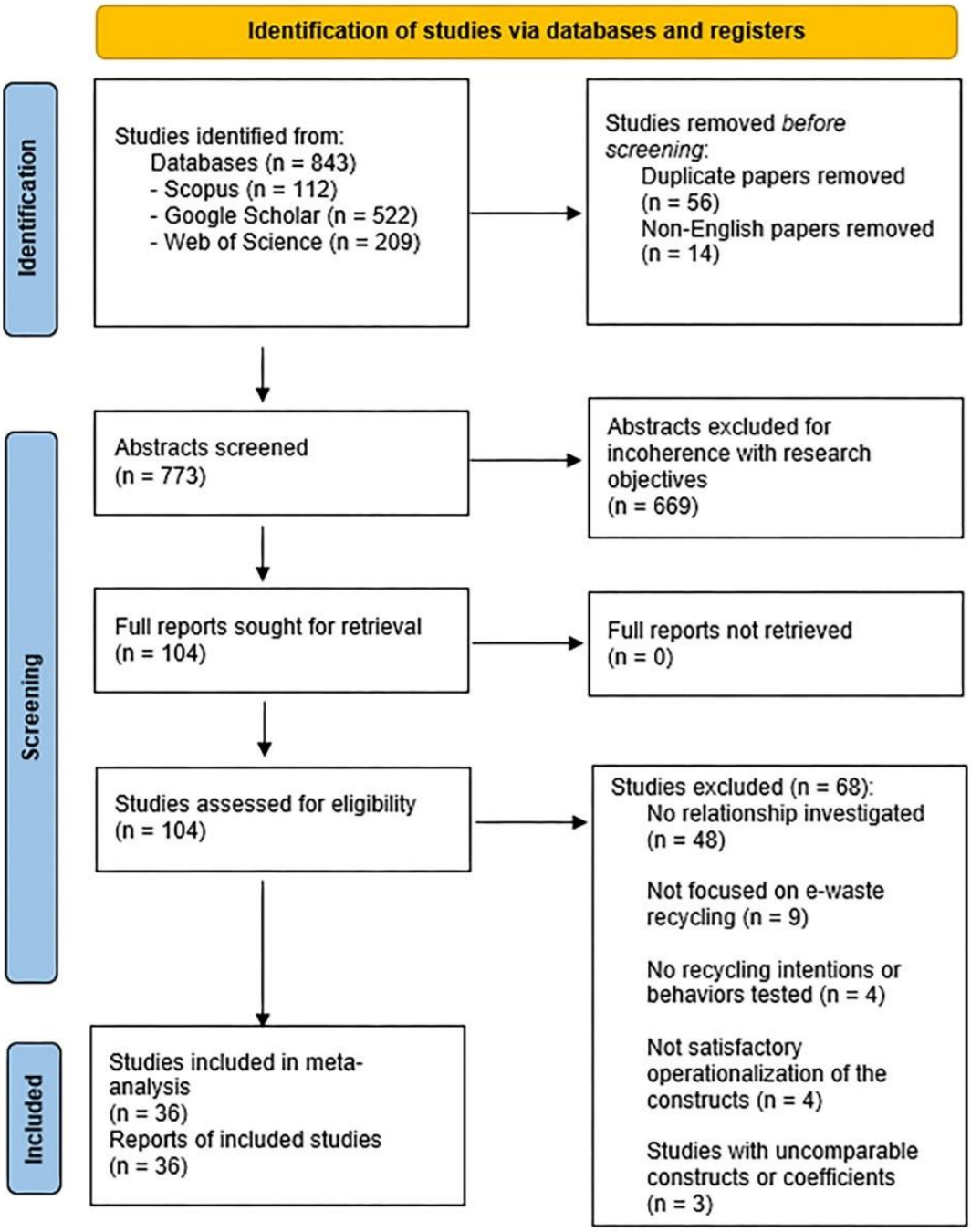

Figure 6. The screening process.

Table 2. List of included studies and corresponding retained variables.

Study	INT	BEH	ATT	SN	PBC	PN	CONV	EK	PB	PR	EB	EC	PE	HAB
Aboelmaged et al., 2021	✓		✓	✓	✓									✓
Ardi et al., 2020	✓		✓	✓	✓									
Cheng et al., 2020	✓		✓	✓	✓		✓		✓		✓			
Delcea et al., 2020	✓	✓	✓	✓	✓		✓	✓					✓	
Dhir et al., 2021a			✓						✓	✓				
Dhir et al., 2021b	✓								✓	✓				
Dixit and Badgaiyan, 2016	✓	✓	✓	✓	✓	✓								
Kochan et al., 2016	✓	✓		✓			✓	✓						
Gu, 2017	✓	✓		✓					✓					
Jabbar, 2018	✓		✓											
Kianpour et al., 2017	✓		✓	✓	✓				✓	✓	✓			
Koshta et al., 2022	✓		✓	✓	✓			✓						
Kumar, 2017	✓		✓		✓				✓					
Kumar, 2019	✓		✓	✓	✓	✓	✓	✓						
Le et al., 2012			✓	✓	✓			✓			✓			✓
Liu et al., 2019	✓		✓	✓	✓	✓	✓							
Mahmud et al., 2020	✓		✓	✓	✓	✓	✓	✓						
Mouton, 2020	✓		✓	✓			✓	✓				✓		
Najmi et al., 2020	✓	✓	✓	✓	✓	✓		✓						
Nduneseokwu et al., 2017	✓		✓	✓				✓						
Nguyen et al., 2018	✓			✓			✓					✓	✓	
Nyeko et al., 2022	✓								✓	✓				
Papaoikonomou et al., 2020	✓		✓	✓	✓	✓								
Peng et al., 2018	✓										✓			
Ran and Zhang, 2022	✓	✓												
Sarathchandra and Hettiarachchib, 2020	✓		✓	✓			✓	✓						
Sari et al., 2021	✓		✓	✓	✓						✓		✓	
Shaharudin et al., 2020	✓	✓		✓			✓		✓				✓	
Sharif and Keat, 2017		✓	✓	✓			✓	✓						
Simamora et al., 2021	✓				✓		✓							
Siringo et al., 2020	✓				✓			✓					✓	
Wang et al., 2016	✓		✓									✓		
Wang et al., 2018	✓		✓	✓	✓	✓		✓						
Wang et al., 2019	✓		✓	✓	✓						✓			
Xu et al., 2014	✓		✓	✓	✓									
Zhang et al., 2019	✓		✓	✓			✓					✓		✓

Note: INT = Intentions to recycle e-waste; BEH = E-waste recycling behaviours; ATT = Attitudes; SN = Subjective Norms; PBC = perceived behavioural control; PN = Personal norms; CONV = Convenience; EK = Environmental Knowledge; PB = Perceived Benefits; PR = Perceived Risks; EB = Economic Benefits; EC = Economic Costs; PE = Policy Effectiveness; HAB = Habits.

5.3.3. Analyses

Prior to analysis, we converted all effect size information to Pearson's *r* employing standard formulas. Analyses were conducted using the metafor (Viechtbauer, 2010) and psychmeta (Dahlke and Wiernik, 2019) R packages. We calculated meta-analytic estimates using Schmidt and Hunter's (2015) approach. Using Schmidt and Hunter's (2015) approach, the analysis produced the mean and corrected effect size, the standard deviation for both, 95% confidence intervals (95%-CIs) and 80% credibility intervals (80%-CVs). A random-effect model was adopted. The 95%-CIs surrounding the effect size were used to determine the statistical significance of such effect. The presence of outliers and influential cases was examined by computing different outlier and influential case diagnostics (Viechtbauer and Cheung, 2010). We also computed corrected correlations for scale reliability estimates reported in each study. When reliability estimates were not reported, we imputed reliability based on the artifact distribution for that variable using the bootstrap method. In addition to the 80% credibility intervals, we computed the *Q* and *I2* statistics to examine the heterogeneity between the studies. When sufficient primary studies were retained ($k > 15$), and in case of a significant *Q* statistic and an *I2* of 75% or more, moderation hypotheses were tested (i.e., meta-regression procedure).

Rs in the ranges of 0.10, 0.20, 0.30, and 0.40 were considered small, medium, large, and very large (Gignac and Szodorai, 2016; Funder and Ozer, 2019). Considering that the research integrates findings from more than 18000 participants, we considered very large effect sizes in the range of 0.40 as being sufficiently reliable (Valentine et al., 2019). Moreover, a meta-analysis conducted on 250 meta-analyses found that the mean differences between uncorrected *r* and corrected ρ are around 0.05 (Paterson et al., 2016). We thus interpreted as overestimation the effect sizes whose difference between *r* and ρ is higher than 0.10. Meta-regression was performed using observational study quality evaluation, age, gender, and region of data collection. In terms of region of data collection, we adopted the distinction into developed and developing countries presented by the World Economic Situation and Prospects 2023 Report of the United Nations.

5.4. Results

We extracted 171 effect sizes from 37 samples found in 36 studies. There were 18,410 participants with an average of 498 respondents per sample. The 89% of the sample represented participants from developing countries, with only 11% of the sample being composed of participants from developed countries. The samples were on average composed of 45% women, for the 16 studies where gender was reported, while on average participants were 31 years old. The samples were drawn from common citizens. Our findings revealed that the most investigated predictors of intentions were attitudes (k = 25), subjective norms (k = 25), perceived behavioral control (k = 21), knowledge (k = 14), and convenience (k = 12).

Appendix F presents results for the meta-analysis of bivariate correlations. The results of our study align with the theoretical underpinnings of the theory of planned behaviour. Consistent with expectations, behaviours demonstrated a substantial and positive correlation with intentions (ρ = .42; 95% CI [0.29, 0.56]). Furthermore, intentions exhibited significant positive associations with attitudes (ρ = .42; 95% CI [0.35, 0.50]), subjective norms (ρ = .35; 95% CI [0.26, 0.43]), and perceived behavioural control (ρ = .35; 95% CI [0.27, 0.43]). Consequently, *H1, H2, H3,* and *H4* were supported.

Expanding our investigation to include extended versions of the theory of planned behaviour, our results revealed significant correlations between intentions and knowledge (ρ = .33; 95% CI [0.22, 0.44]), convenience (ρ = .49; 95% CI [0.33, 0.64]), policy effectiveness (ρ = .48; 95% CI [0.16, 0.80]), and economic benefits (ρ = .34; 95% CI [0.19, 0.48]). This provides support for *H5, H6, H7*, and *H8*. Intriguingly, intentions were not significantly associated with economic costs (ρ = -.22; 95% CI [-0.76, 0.33]), leading to the rejection of *H9.*

Moving on to other theories, the analysis of personal norms revealed a positive and significant association with intentions (ρ = .36; 95% CI [0.12, 0.60]), offering strong support for this moral variable as posited in *H10*. Nevertheless, our study yielded unexpected results in relation to habits. The relationship between habits and intentions was found to be non-significant (ρ = .25; 95% CI [-0.59, 1.08]), resulting in the rejection of *H11*. Additionally, our data provided ambivalent support for

psychological variables taken from behavioural reasoning theory. While perceived benefits displayed a positive relationship with intentions (ρ = .53; 95% CI [0.44, 0.62]), risks did not exhibit a significant correlation with intentions (ρ = .25; 95% CI [-0.63, 1.13]). As a result, *H12* was supported, but *H13* was rejected.

5.4.1. Heterogeneity of data and meta-regression results

Appendix F shows 80% CR, Cochran's Q, and the I^2 statistic. The results show a high degree of heterogeneity, suggesting the existence of potential moderators. In response to this, a meta-regression analysis was conducted for outcomes characterized by a minimum of 15 effect size estimates. This analysis specifically addressed the relationships between (1) attitudes and intentions; (2) subjective norms and intentions; and (3) perceived behavioural control and intentions. Table 3 presents the outcomes of the meta-regression analysis examining relationships within studies with a minimum of 15 effect sizes. The analysis incorporated factors such as observational study quality evaluation., age, gender, and World Economic Situation and Prospects classification. Regarding the relationship between attitudes and intentions to recycle, we observed a positive correlation with age (r = 0.02, p < .01), indicating that the effect size increased with advancing age. Despite the attempt to mitigate heterogeneity through meta-regression, the residual heterogeneity remained substantial (Q = 91.86, df = 11, p < .001; I^2 = 75.91%). In the context of the relationship between subjective norms and intentions, the meta-regression analysis revealed a moderating effect of the observational study quality evaluation score (r = 0.26, p < .01). However, even with this moderating correlation, the residual heterogeneity persisted at a high level (Q = 115.57, df = 12, p < .001; I^2 = 89.74%). Lastly, the meta-regression analysis for the relationship between perceived behavioural control and intentions demonstrated that the observational study quality evaluation score had a moderating effect (r = 0.18, p < .05). Significant residual heterogeneity persisted (Q = 95.42, df = 10, p < .001; I^2 = 82.30%) despite this moderation.

Table 3. Meta-regression results.

Variables	k	Coefficient	S.E.	z	95% CI
Attitudes - Intentions	25				
OSQE	25	0.06	0.07	0.88	-0.08, 0.20
Age	18	0.02**	0.01	3.17	0.01, 0.03
Gender	19	-0.08	0.25	-0.32	-0.57, 0.41
WESP	25	0.12	0.10	1.13	-0.08, 0.31
Subjective Norms - Intentions	25				
OSQE	25	0.26**	0.10	2.67	0.07, 0.45
Age	18	0.02	0.01	1.91	-0.01, 0.03
Gender	20	-0.38	0.34	-1.10	-1.05, 0.30
WESP	25	0.12	0.13	0.88	-0.15, 0.38
Perceived Behavioral Control - Intentions	21				
OSQE	21	0.18*	0.08	2.33	0.03, 0.33
Age	16	0.01	0.01	0.58	-0.01, 0.02
Gender	17	-0.09	0.27	-0.32	-0.61, 0.44
WESP	21	0.14	0.11	1.30	-0.07, 0.35

Note: k = number of studies contributing to meta-analysis; S.E. = standard error; *z* = standardized coefficient; *CI* = Confidence Interval; OSQE = Observational Study Quality Evaluation**;** WESP = World Economic Situation and Prospects. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

5.5. Discussion

The current meta-analytic study aimed to determine the strength of the relationships between key theory-based psychological factors and people's e-waste recycling intentions and behaviours. First, as expected, the intentions-behaviours relationship displayed a very large effect size. We found very large effect sizes also for intentions' relationship with attitudes, convenience, and policy effectiveness, respectively. Additionally, the association between intentions and subjective norms, perceived behavioural control, economic benefits, environmental knowledge, and perceived benefits resulted significant and showed positive effect sizes. Personal norms showed a large positive correlation with intentions; while habits, perceived risks, and economic costs were not significantly related to intentions to recycle e-waste. Table 4 shows the hypotheses we developed and whether our findings support or reject them.

Table 4. Hypotheses and results summary

Hypothesis	Relationship	Supported/Rejected	Effect size interpretation (Funder and Ozer, 2019)
H1	Intentions → Behaviours	Supported	Very large
H2	Attitudes → Intentions	Supported	Very large
H3	Subjective Norms → Intentions	Supported	Large
H4	Perceived Behavioural Control → Intentions	Supported	Large
H5	Environmental Knowledge → Intentions	Supported	Large
H6	Convenience → Intentions	Supported	Very large
H7	Policy Effectiveness → Intentions	Supported	Very large
H8	Economic Benefits → Intentions	Supported	Large
H9	Economic Costs → Intentions	Rejected	Non-significant
H10	Personal Norms → Intentions	Supported	Large
H11	Habits → Intentions	Rejected	Non-significant
H12	Perceived Benefits → Intentions	Supported	Large
H13	Perceived Risks → Intentions	Rejected	Non-significant

5.5.1. Attitudes, Subjective Norms, and Perceived Behavioural Control.

In line with the established body of literature, our results fully support the theory of planned behaviour (Ajzen, 1991). We found that attitudes, subjective norms, and perceived behavioural control significantly correlate with intentions, the latter being significantly and positively associated with

behaviours. Our findings support the idea that the qualitative evaluation of e-waste recycling, whether positive or negative, has a larger effect on intentions than the perceived social pressure or the degree of difficulty of the behaviour. This is partially in line with results from previous research studies: a meta-analysis by Klockner and colleagues (2013) found a large effect size for both attitudes and perceived behavioural control in their relationships with intentions to recycle diverse types of waste, while subjective norms displayed a medium effect size. The literature has provided substantial evidence on the importance of attitudes in shaping intentions (Parajuly et al., 2020); our results add up to this, as they suggest that attitudes have the largest effect size out of the three variables. Differently from what was argued by past cross-sectional studies (Kumar et al., 2017), subjective norms do not have a lesser role than perceived behavioural control when affecting intentions.

5.5.2. Environmental Knowledge

We also found that knowledge shows a large and positive correlation with intentions. This finding supports the idea that intentions are shaped based on cognition: before individuals can intentionally act on e-waste recycling issues, they must know the existence of these e-waste-related problems (Hines et al., 1986). Our findings align with previous reviews of the literature: Parajuly and colleagues (2020) state that behaviours are related to knowledge and beliefs about environmental impacts (Saphores et al., 2012). In a more recent review, Islam and colleagues (2021) highlight that a lack of information related to e-waste is one of the critical aspects shaping intentions. It seems likely that e-waste recycling is misunderstood as being too complicated. Therefore, we argue that knowledge of basic e-waste issues — such as the consequences of not recycling e-waste — is an important cognitive variable that correlates with e-waste recycling intentions.

5.5.3. Convenience

Based on the findings of our meta-analysis, we argue that situational or external factors play a role in e-waste recycling intentions. Reliability and accessibility of e-waste management services (e.g., the number of collection points available in a territory) are crucial situational factors that build perceived

convenience, which in turn fosters intentions (Islam et al., 2021). Our findings support this idea, as convenience was strongly found to positively correlate with intentions. Past survey investigations report convenience as one of the main reasons for planning to recycle e-waste (Kurisu et al., 2020; Zhang et al., 2019). We argue that this is because recycling e-waste is not as easy and convenient as recycling other types of waste. Recycling e-waste is not immediate, and requires planning, time, and prospective thinking to be effectively performed (Wagner, 2013). People consider convenience when they plan how to recycle e-waste and, thus, when they form the intention to perform this behaviour. Summing up, recycling e-waste is a time-consuming activity, and intentions thus must be formed before the corresponding behaviour can be executed. Our findings suggest that convenience (e.g., reliability and accessibility of collection points) helps to flexibly arrange and plan how people intend to recycle e-waste.*5.5.4. Policy Effectiveness*

Moreover, our results showed that policy effectiveness is related to intentions, displaying a very large effect size. Our finding is in line with what reported by Wan and Shen (2013): if a policy is perceived as efficient and useful, people are more motivated to act accordingly. Our results are consistent with previous research reporting that governments implementing e-waste recycling policies have influenced users' intentions to recycle (Wan et al., 2014; Shaharudin et al., 2020). It is important to highlight that these studies were conducted in countries whose governments simultaneously disseminate guidelines on how to dispose of e-waste and show a lack of structured management systems (Rasheed et al., 2022). Commenting on this ambivalence, our results point to the idea that sharing accurate information on e-waste disposal may be sufficient to ignite perceptions of policy effectiveness and, thus, enhance e-waste recycling intentions (Shaharudin et al., 2020).

5.5.5. Economic Benefits and Cost

Our study shows that the associations linking economic benefits and intentions yielded a significantly large effect size, while the relationship between economic costs and intentions was non-significant. Our finding is in contrast with the literature (Wang et al., 2011; 2016; 2019), as it suggests that overall benefits correlate with intentions to recycle e-waste while costs may not be as relevant. In other words,

the costs associated with recycling e-waste are currently negligible and do not affect intentions. Therefore, citizens develop intentions to properly recycle e-waste based on the economic benefits provided by their government or administration's policies.

5.5.6. Personal norms

Our findings confirm the key role that morality plays when it comes to environmental sustainability, as personal norms largely and positively correlate with intentions. This insight suggests that individuals' values and moral system compels them to behave accordingly, thus forming their intentions to act (Shwartz and Howard, 1981). Our findings add to the existing literature on personal norms and e-waste recycling intentions, highlighting how these behavioural intentions can be associated with moral drivers.

5.5.7. Habits

According to Wang and colleagues (2011), habits are one of the most paramount factors in determining e-waste recycling intentions. Moreover, a previous meta-analysis showed that habits are a powerful cause of pro-environmental behaviour (Klockner, 2013). Our study is in clear contrast with these findings, as we did not find any significant correlation between habits and intentions. This surprising result can be explained examining the theoretical foundation of our work; habits play a prominent influence on repetitive behaviours. Given that the frequency of a behaviour is related to habit strength (Klockner, 2013), habits display a weak association with behaviours that are performed more rarely (Triandis, 1980). This is confirmed by another meta-analytic study, which found that habits have a weak influence on behaviours that are performed only annually or biannually (Ouellette and Wood, 1998). Our results confirm that e-waste recycling is not performed as frequently as it would be necessary for a habit to be established. This could be because electronic products degrade more slowly than other types of waste (Ongondo et al., 2015). Moreover, disposal infrastructures do not entail a frequent collection of e-waste from consumers (Wagner et al., 2013; Islam et al., 2021).

Summing up, our results suggest that people recycle e-waste so rarely that they hardly establish the corresponding habit. Therefore, in the specific case of e-waste, habits may not relate to intentions.

5.5.8. Perceived benefits and risks

Similar to the case of economic benefits and costs, we found that perceived benefits have a large positive correlation with intentions, while risks display a non-significant one. These results suggest that people mostly consider personal and environmental benefits when they form intentions, and they neglect the barriers associated with this behaviour. This is in contrast with previous research that found significant effects of both benefits and risks on e-waste recycling intentions (Dhir et al., 2021b; Kumar et al., 2017; Shaharudin et al., 2020; Nyeko et al., 2022). It appears that e-waste is perceived differently than other types of waste, as users evaluate recycling risks and costs as not important when deciding whether to recycle. On the other hand, people seem to heavily rely on the environmental, personal, and economic benefits of recycling to form their e-waste disposal intentions.

5.5.9. Moderation effects: age, gender, study quality.

Stemming from our meta-regression analysis, we found that elders display a stronger correlation between attitudes and intentions than younger participants. One explanation for this finding is that younger individuals are more likely to believe that future technological advancements will solve environmental issues, thus making it unnecessary for them to limit their consumption (Benn, 2004). Similarly, research conducted among university students has shown that while they hold strong environmental attitudes, they are unwilling to make significant changes to their behaviour (Kagawa, 2007). As a result, they do not feel the same urgency to engage in pro-environmental behaviour, despite holding stronger attitudes than older individuals. Similar findings can be found in studies focusing on e-waste as well: Nduneseokwu and colleagues (2017) found an effect of age on e-waste recycling intentions and a difference among consumers of different age groups with respect to their intentions. Our results thus add to the existing literature on e-waste, as elders display a stronger correlation between attitudes and intentions.

Surprisingly, we could not find any significant moderation for gender. Our findings are in contrast with previous literature: according to Gender Schema Theory (Bem, 1983), women perceive the usefulness of brand-new electronic technology less than men (Taherdoost, 2019). Ko and colleagues (2019) suggest that women are less likely to dispose of e-waste compared to men. As a follow-up to these findings, Fan and colleagues (2022) investigated the moderating role of gender between distinct types of motivation and e-waste recycling intentions. They found that men are more intrinsically motivated to dispose of e-waste, while women feel more the impact of external motivation to enact this behaviour. Our results add up to this statement: their motivations might be different, but men's and women's attitudes, subjective norms, and perceived behavioural control correlate to the same degree with intentions. Connecting this finding with previous literature (Taherdoost, 2019; Ko et al., 2019), women could find it more difficult than men to turn their e-waste recycling intentions into behaviours because they do not receive sufficient external motivation to do so (Fan et al., 2022). Finally, we found that, among studies of high quality, subjective norms and perceived behavioural control were more strongly related to intentions. This finding advocates for undertaking higher-quality research able to understand subjective norms and perceived behavioural control effects on intentions more correctly.

5.5.10. Limitations of the present study.

This work suffers from several limitations, notably related to the high heterogeneity of construct operationalization in the included studies. As encouraged by Fishbein and Ajzen (2010), the theory of planned behaviour does not envisage a standard questionnaire to measure the main constructs, and researchers are required to develop a study-specific (e.g., for the specific population and behaviour) questionnaires. For each article, we have looked up as much as possible information on the definition, scale, and items used to operationalize these constructs. While we believe to have successfully managed to solve this issue for the present study, future research should take into consideration the possibility of developing common and validated scales for e-waste recycling antecedents, as well as its corresponding advantages.

This research faces a methodological limitation due to a lack of available samples for some variables (e.g., habits, perceived convenience). This shortage determines less robust estimates, making it necessary to conduct further studies to examine the explanatory power of these variables in predicting intentions and behaviours. It is crucial to exercise caution when interpreting estimates based on a relatively small number of samples. Similarly, the literature does not offer a sufficient number of studies framed within the value-belief-norm, habit, or behavioural reasoning theories, making it currently impossible to compare them with the theory of planned behaviour or to test a general model. Future research designs should aim to be framed within two or more theories, contributing to closing this gap and comparing them in future reviews or meta-analyses. Moreover, 13 studies only included beta coefficients from structural equation modeling analyses, so we had to convert them by using the Peterson and Brown (2015) formula. A best practice for future research could be to provide correlation coefficients for the relationships between every possible pair of the study's variables.

The methodological adequacy of the research base is another important limitation of this meta-analysis. The studies investigating the key theory-based correlates of e-waste recycling intentions and behaviours are entirely cross-sectional in nature. Future prospective, longitudinal, and experimental research is needed to better understand the causal mechanisms. Moreover, few studies have investigated the predictors of e-waste recycling behaviour. This is an important limitation of the literature, as most studies used intentions as the main outcome. Although it is clear in the experimental research literature that a change in intention leads to a modification in behaviour (Webb and Sheeran, 2006), the investigation of the proximal predictors of e-waste recycling behaviour is crucial. Future research should consider more situational and external variables specific to e-waste recycling management that might affect how intentions turn into behaviours. Considering our meta-regression results, it would also be interesting to investigate the role of gender in affecting how intentions shape behaviours.

5.5.11. Implications for research and practice

Our meta-analysis entails different implications for researchers. First, future research should exercise caution when interpreting the role of habits in influencing e-waste recycling intentions. People do not frequently need to dispose of e-waste because it degrades at a slower rate than other typologies. We argue that habits to recycle e-waste can be hardly established, as current collection policies require people to rarely perform this behaviour. Moreover, our meta-analysis seems to suggest that the adverse consequences of e-waste recycling (i.e., perceived risks and economic costs) do not affect people's decisions to dispose of e-waste. On the other hand, economic benefits and perceived benefits are crucial factors that correlate with e-waste recycling intentions. Future research could delve more into this aspect, identifying which benefits are more important in making people recycle e-waste.

Our results also suggest that researchers should delve more into how situational factors might affect intentions. While the role of psychological variables is of paramount importance, it is still unclear how citizens evaluate different situational facilitators and barriers to e-waste recycling. Our meta-analysis points out that convenience is an important situational factor in relation to intentions. Investigating which aspects of convenience (e.g., proximity, opening hours, accessibility, and user experience of the collection centre; Wagner et al., 2013) exert a more influential role remains an open research question.

Finally, the examined body of literature mostly relied on self-report measures of e-waste recycling behaviour. Future research should investigate whether other measures of e-waste recycling behaviour (e.g., data from e-waste collection points) are differentially predicted by the hypothesized determinants. Moreover, broader research on potential moderators between antecedents, intentions, and behaviour is needed. In a literature review, Knussen and Yule (2008) report that the absence of a recycling habit moderates the relationship between attitude and intention, suggesting that individuals without such a habit may have treated recyclables as regular garbage in the past. Future research could investigate whether habits play a moderating role between attitudes and intentions to recycle e-waste. Moreover, whether the nature of the recycled e-waste affects e-waste recycling behaviours is an open research question. In 2022, the recycling rate for televisions in Japan was 72% (Statista, 2022a), while

washing machines were recycled at a 92% rate in the same year (Statista, 2022b). Additionally, future longitudinal research is needed to better understand the temporal relations between the variables (Velicer and Fava, 2003).

Our findings pinpoint potential targets for intervention to enhance e-waste recycling intentions and behaviours. The Behaviour Change Wheel (Michie et al., 2011) serves as a valuable methodology for identifying various intervention areas and connecting them to potential policies that can drive behavioural change. Aligning our results with this methodological framework, we contend that practitioners and policymakers should focus on implementing interventions targeting diverse areas. Specifically, we emphasize the critical role of education in improving people's knowledge, which can deepen their understanding of the environmental benefits and risks of e-waste recycling and raise awareness on this issue. Additionally, interventions centred on persuasion may prove effective by using mass communication to foster positive attitudes toward e-waste recycling and influence intentions. Exploring incentivization is also recommended, along with the implementation of rewards in the recycling process (e.g., economic incentives, benefits). Furthermore, enabling e-waste recycling by increasing means or reducing barriers could positively affect convenience, facilitating planning for recycling. Conversely, areas of restriction and coercion may not strategically enhance e-waste recycling, as economic costs and risks have a minimal impact on intentions. A recent meta-analysis by Allison and colleagues (2022) partially supports this perspective, highlighting persuasion and enablement as key areas associated with significant behavioural changes.

The Behaviour Change Wheel links these intervention areas to potential policies for action, including communication marketing, guidelines, fiscal regulation, and legislation (Michie et al., 2011). Given the array of intervention options, practitioners and policymakers may find the use of intervention mapping (Bartholomew et al., 1998) beneficial in identifying strategies capable of influencing these policies. Intervention mapping expands the traditional three major intervention program activities (i.e., needs assessment, program development, and evaluation). The authors recommend designing interventions through five consecutive steps: (1) creating a matrix of proximal program objectives,

(2) selecting theory-based intervention methods and practical strategies, (3) designing and organizing a program, (4) specifying adoption and implementation plans, and (5) generating program evaluation plans.

E-waste is a peculiar type of waste, as it degrades much slower than other types of waste (Ongondo et al., 2015) and is seldom recycled by people (Baldé et al., 2017). Incentivizing people to properly dispose of e-waste is crucial to reducing global warming and recovering raw materials, ultimately contributing to ameliorate the e-waste crisis. This meta-analysis aimed to determine the strength of the relationship between key theory-based psychological factors and people's e-waste recycling intentions and behaviours. While many well-established effects were confirmed, our results highlighted how attitudes, convenience, and policy effectiveness are the most important correlates to e-waste recycling intentions. It is crucial to undertake user-centred interventions to enhance e-waste collection, as general population is the one that decides whether and how to dispose of e-waste (Borthakur and Govind, 2018). We recommend the use of intervention mapping (Bartholomew et al., 1998) as a strategic tool to identify intervention strategies. This may influence policies associated with "persuasion" and "enabling" intervention areas, as outlined by Michie et al. (2011) and supported by recent studies (Allison et al., 2022). This approach aims to streamline the process of facilitating e-waste recycling intentions and behaviours, thereby enhancing the overall effectiveness of interventions in these targeted domains.

6. Chapter 4: "I want to recycle, but..." - Understanding how situational factors affect e-waste recycling behaviours (Study 2)

Puzzo, G., & Prati, G. (2024). Unraveling the influence of convenience situational factors on e-waste recycling behaviors: A goal-framing theory approach. *Sustainable Development,* 1–18. https://doi.org/10.1002/sd.3164

6.1. Introduction

The first study of this thesis determined that attitudes, policy effectiveness, and convenience are the strongest antecedents of e-waste recycling intentions, as they display "very large" effect sizes. Despite 2 out of the 3 most important antecedents are situational factors (i.e., convenience and policy effectiveness), our meta-analysis and other reviews (Parajuly et al., 2020; Islam et al., 2021; Thukral et al., 2023) show that most studies focus on exploring internal antecedents of e-waste recycling (i.e., attitudes). This proclivity fails to consider that individuals occasionally exhibit behaviours that are incongruent with their motivations due to situational factors (Verplanken & Holland, 2002). According to some authors, situational factors are also key variables that affect the intentions-behaviour gap (e.g., Zhang et al., 2019; Wang et al., 2019; Cheng et al., 2020). Specifically, in our meta-analysis we reported a lack of research samples that investigate convenience, advocating for more studies that assess how situational factors affect e-waste recycling behaviours. The second study of this thesis thus aimed to bridge this gap by exploring the role of convenience situational factors in affecting e-waste recycling behaviours within the theoretical lenses of goal framing theory.

Framing studies within the goal-framing theory is an innovative approach to study e-waste recycling behaviours, as it considers the influence of situational factors by directing people's attention toward multiple goals (Canto et al., 2023). In fact, the goal framing theory posits that different environmental values and situational factors affect three types of goals (i.e., hedonic, gain, and normative; Lindenberg & Steg, 2007). In turn, these goals clash with each other to shape an overarching objective, subsequently influencing pro-environmental behaviour. Framed within this theory, the present study aims to investigate the role of convenience situational factor (i.e., proximity,

availability, and user experience of the collection centre) in affecting e-waste recycling behaviours - both directly and via gain, normative, and hedonic goals - in a European sample (e.g., Italian citizens).

This study bridges an important gap in the literature on psychological antecedents of e-waste recycling. In fact, to the extent of the authors' knowledge, this is the first research that applies goal framing theory to investigate e-waste recycling behaviours. Arguably, this is an innovative approach because it considers the unique interaction between situational factors and people's motivations, as the former might foster decisions on e-waste recycling that contradict people's goals. For example, Steg and colleagues (2014) elucidate in a review how individuals are less inclined to adhere to normative goals when the associated behaviour involves relatively high costs or efforts, such as choosing cycling over driving a car. This study will contribute to conduct more relevant research studies and to implement more efficient practices regarding e-waste proper disposal. On one hand, this study may show the adequacy of goal framing theory to encompass the complex interaction between situational factors and people's behavioural goals, thus opening a new venue for research. On the other hand, understanding which goals are more relevant when planning to recycle e-waste may lead the way to design communication campaigns or e-waste management practices that may effectively enhance citizens' e-waste recycling behaviours.

6.2. Theoretical Background

According to goal framing theory (Lindenberg and Steg, 2007), environmental behaviour is driven by three types of goals: gain (i.e., monitoring personal resources), normative (i.e., meeting obligations and promoting appropriate conduct), and hedonic (i.e., seeking pleasure and avoiding effort). The dominant goal, or "goal-frame", shapes attention, perception, and behaviour (Steg et al., 2016). Background goals can strengthen or weaken the focal goal, often subconsciously influenced by individual traits and environmental cues (Steg et al., 2014). Research in environmental psychology shows how normative goals are less predictive of behaviour when the latter is more effortful, costly, time-consuming, or uncomfortable, as they clash with the achievement of gain and hedonic goals (Steg et al., 2011).

Bamberg and Schmidt (2003) disseminated a survey among 608 university students to predict which psychological variables influenced car use and found that factors related to gain goals (i.e., reduced effort or cost) were more influential than ones related to normative goals (i.e., personal norms). In an experimental study, Dogan and colleagues (2011) showed that people were less successful in reducing fuel consumption when they simultaneously had a gain goal conflicting with environmental norms (i.e., needing to be on time for an appointment). Keizer (2014) replicated this finding with a larger sample of 15,000 people spread across 7 European countries, showing that normative considerations predicted short-distance car trips (since it is perceived as easier to avoid), but not overall car use (due to a perceived lack of feasible alternatives). Considering these findings, arguably normative goals clash with hedonic and gain goals when people choose to recycle e-waste, since recycling in collection centres is often less convenient and more effortful than improper disposal (Islam et al., 2021).

H1. Gain Goals will be negatively related to e-waste recycling behaviours.

H2. Normative Goals will be positively related to e-waste recycling behaviours.

H3: Hedonic Goals will be negatively related to e-waste recycling behaviours.

Values play a crucial role in determining the prominence of hedonic, gain, and normative goals, thus influencing the likelihood of a particular goal becoming focal. While goals, as discussed earlier, represent the motivations that drive individuals within a given context, values represent the overarching priorities individuals hold in life in general. Steg and colleagues (2014) identified three distinct types of values, namely hedonic, egoistic, and biospheric. Hedonic values are centred around improving one's feelings and reducing effort, while egoistic values revolve around the protection or increase of personal resources. On the other hand, biospheric values are concerned with nature and the environment for their intrinsic worth.

When individuals make personal choices, they tend to favour options that align with their core values (Verplanken & Holland, 2002). These values hold such significance that they dictate which goals are

deemed most crucial to individuals (Steg et al., 2016). By influencing the prominence and accessibility of goals, values play a pivotal role in determining the probability of a specific goal becoming prominent in a given situation. Steg and colleagues (2012) examined relationships between values and environmental behaviours between 468 people from the Netherlands. Participants with strong biospheric values valued the biospheric aspects of the restaurants (i.e., presence of organic food), while those with strong hedonic values reported to mostly seek pleasure (i.e., tastiness of food served). This study thus adheres to the hypotheses of previous studies in the field (e.g., Steg et al., 2016).

H4: Egoistic values positively relate to gain goals.

H5: Biospheric values positively relate to normative goals.

H6: Hedonic values positively relate to hedonic goals.

It is worth noting that individuals may exhibit behaviours that contradict their core values due to the influence of situational factors on choices' perceptions (Verplanken & Holland, 2002). In fact, goal framing theory posits that situational factors operate in many ways, as they affect the predominance of hedonic, gain, and normative goal-frames in shaping behaviour (Steg et al., 2014). Focusing on e-waste, convenience is a particularly important situational factor that affects the predominance of hedonic, gain, and normative goal-frames, since citizens have to diligently plan how, when, and where to dispose of it to successfully do so (Borthakur & Govind, 2018).

Wagner (2013) points out that convenience, defined as the ease and accessibility of e-waste recycling services (Mohamad et al., 2022), is defined by different categories: proximity to the collection centre (i.e., distance and time to reach a collection site), availability (i.e., opportunities to recycle e-waste through more flexible opening hours) and user experience (i.e., the smoothness and easiness of the disposal process).

To the extent of the authors' knowledge, no study has ever investigated how situational factors affect gain, normative, and hedonic goals within the setting of e-waste recycling behaviours. Nevertheless,

reviews of the literature suggest that this relationship is theoretically possible, as they highlight how situational factors in different contexts (i.e., tempting chocolates, money-related signs, or organic labels) may prime gain, normative, and hedonic goals (Steg et al., 2016) and, thus, steer people's pro-environmental behaviours accordingly (Canto et al., 2023). In an experimental study, Hahnel and colleagues (2014) investigated how normative symbols (i.e., environmental pictures) influenced evaluations of electric vehicles. Their results showed that people evaluated electric vehicles more positively when their normative goal was activated through environmental pictures. Considering these theoretical foundations and findings, this study hypothesizes the following:

H7: Convenience of the collection centre positively relates to gain goals.

H8: Convenience of the collection centre positively relates to normative goals.

H9: Convenience of the collection centre positively relates to hedonic goals.

Goal framing theory posits that situational factors (i.e., convenience) can also affect behaviour directly (Steg & Vlek, 2009). In an experiment by Fujii and Kitamura (2004), 23 drivers received a one-month free bus ticket, while 20 drivers did not. Findings showed that there was an upsurge in bus ridership for people that received the free bus ticket. Focusing on e-waste, Bouvier and Wagner (2011) studied how availability of collection centres impacted the household collection rate of e-waste in Maine, USA. They found a positive correlation between the per capita e-waste collection rate and the number of days facilities were open.

Another study by Ongondo and Williams (2011) surveyed 79,000 university students in the UK and discovered that user experience was a key factor in choosing cell phone recycling programs. More recently, a survey on e-waste recycling practices among nearly 900 people revealed that convenience was positively associated with e-waste recycling behaviours (Zhang et al., 2019). Arain and colleagues surveyed 7500 people to assess e-waste recycling behaviours and found that proximity was one of the most significant factors influencing e-waste recycling decisions. Table 5 summarizes recent research in the field and how each study contributes to formulate the corresponding hypothesis.

Figure 7 shows a graphical representation of every hypothesis of the present study, with the latter being:

H10: Convenience of the collection centre positively relates to e-waste recycling behaviours.

Table 5. Summary of most recent research on goal framing theory and e-waste behaviors

Relationship tested	Description	Field	Reference	Hypotheses
Goals → Behaviors	When people had a conflicting gain goal (i.e., needing to be on time for an appointment), they reduced fuel consumption behavior.	Car usage	Dogan et al., 2011	*H1, H2, H3*
	Normative goals predict short-distance car trips, as they are easier to avoid, but not overall car use, as there's a lack of feasible alternatives.	Car usage	Keizer, 2014	*H1, H2, H3*
Gain Goals → Behaviors	Gain goal frames are negatively associated with sustainable food consumption.	Eating habits	Onwezen, 2023	*H1*
Normative Goals → Behaviors	University students' pro-environmental behaviors were stronger for those who possessed strong normative goals to benefit the environment.	Recycling	Chakraborty et al., 2017	*H2*
Hedonic Goals → Behaviors	Strong hedonic goals enhanced the adoption of electric cars.	Car usage	Rezvani et al., 2018	*H3*
Values → Goals	Biospheric values influenced people to focus on organic food options while choosing restaurants, while people with hedonic ones mostly sought tasty food.	Eating habits	Steg et al., 2012	*H4, H5, H6*
Convenience → Goals	Experimental investigation on how situational factors affected goals. Showing environmental pictures activates normative goals, as people evaluated electric vehicles more positively in this case.	Car usage	Hahnel et al., 2014	*H7, H8, H9*
Convenience → Gain Goals	Time-consuming situations reduce willpower to use energy responsibly.	Responsible Energy Usage	Abrahamse and Steg, 2009	*H7*
Convenience → Behaviors	Survey among 900 people, revealing that convenience is positively related with e-waste recycling behavior.	E-waste recycling	Zhang et al., 2019	*H10*
	Survey disseminated among 7500 people, who reported that proximity of the collection center was the main factor affecting their decisions in recycling e-waste.	E-waste recycling	Arain et al., 2020	*H10*

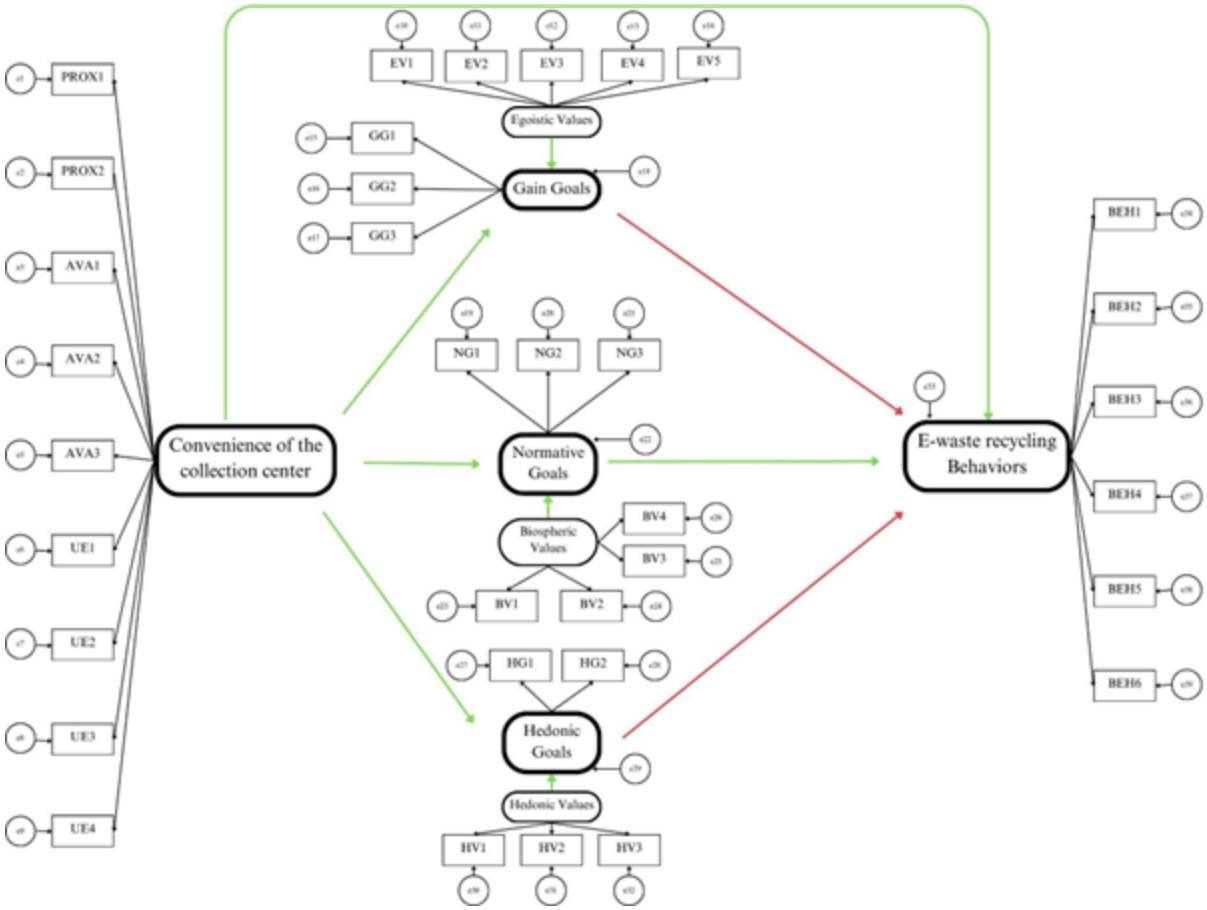

Figure 7. Graphical representation of the tested model. Green arrows represent positive hypothesized relationships, red arrows represent negative ones.

6.3. Materials & Methods

6.3.1. Sample and data collection

The participants in the study were 750 adult citizens (476 women, 274 men; mean age 61 years old) living in the Ferrara and Bologna urban areas of the Emilia Romagna region, Italy. Participants completed a questionnaire-based survey that included different scales between October and November 2023. The survey dissemination process was outsourced to one of the biggest statistical market analysis companies in Italy, which recruited participants through their database and administered the survey via phone. Phone administration was chosen to ensure that participants completed the whole questionnaire and to minimize partial responses.

Sampling and survey administration was completely conducted by the outsourced company, which ensured to have a homogenous geographical and socio-demographic distribution of the participants to minimize potential biases. Participants were considered eligible if they were older than 18 years old. The company contacted participants one by one via phone and, before starting the administration, clarified participants' rights (e.g., voluntary and confidential participation) and the study procedures, ultimately asking to provide their informed consent. The multiservice company contacted more than 1000 people, with 750 of them giving their consent. Detailed socio-demographic data are shown in Table 6.

Table 6. Demographic data and descriptive statistics of the participant sample

Demographic factor	**Descriptive Statistics**
Gender	Men: 274 (36.4%)
	Women: 478 (64.6%)
Age	19-34 years old: 41 (5.5%)
	35-54 years old: 218 (29.0%)
	55-74 years old: 302 (40.2%)
	75-92 years old: 189 (25.1%)
Education	Elementary School: 47 (6.3%)
	Middle School: 140 (18.6%)
	High school: 293 (39.0%)
	Bachelor's degree: 36 (4.8%)
	Master's degree or higher: 142 (18.8%)
	Missing data: 91 (12.1%)
Occupation	Full-time student: 28 (3.7%)
	Full-time occupation: 211 (28.1%)
	Part-time occupation: 51 (6.8%)
	Homely work: 29 (3.9%)
	Unemployed: 14 (1.9%)
	Retired: 352 (46.8%)
	Missing data: 67 (8.9%)
Income level	Very good: 30 (4.0%)
	Adequate: 491 (65.3%)
	Scarce: 99 (13.2%)
	Insufficient: 9 (1.2%)
	Missing data: 123 (16.4%)

6.3.2. Measures

Along with single questions that collected demographic information, the questionnaire contained various measures. Six items were developed to assess e-waste recycling behaviours. Participants were asked to rate on a 5-point Likert scale (1= never; 5 = very often) their frequency of e-waste recycling in the collection centre. Each item corresponded to a different category of e-waste (example items: "Fridges, air-conditioners, refrigerators" and "Laptops, electronic equipment, and smartphones"; α =.85).

Nine items were developed for convenience to encompass three situational factors (e.g., proximity, availability, and user experience; Wagner, 2013). Participants were asked to provide their degree of agreement with each statement on a 5-point scale (1 = completely disagree; 5 = completely agree). Proximity to the collection centre was measured with two items (example item: "You need a lot of time to reach a collection centre") to encompass the space and time dimensions of this variable (r = 0.60). Availability was measured by three items (example item: "Opening days of the collection centre allow you to flexibly reach it"; α = .86). Finally, user experience was measured by four items (example item: "The service offered by the collection centre is efficient;" α = .87). These three subscales converged into one convenience scale, which displayed a strong reliability score (α = .89).

Items for gain, normative, and hedonic goals were adapted from previous literature (e.g., Tang et al., 2020) to fit the context of e-waste recycling. Participants were asked to provide their degree of agreement with each statement on a 5-point scale (1 = completely disagree; 5 = completely agree). Gain goals were measured with three items (example item: "Taking WEEE to the collection centre is a waste of time"; α =.61). Hedonic goals were measured using two items (example item: "Taking WEEE to collection centres is a satisfying activity;" r =.87). Finally, normative goals were measured by three items (example item: "Taking WEEE to the collection centre is the right thing to do;" α =.74).

Measures for hedonic, egoistic, and biospheric values were adapted from Steg and colleagues (2012). Participants were asked to rate the importance of 12 values "as guiding principles in their lives" on

an 8-point scale (0 = not important, 7 = extremely important). Hedonic values included three items (i.e., pleasure, enjoying life, gratification for oneself; α =.79), egoistic values included five items (i.e., social power, wealth, authority, being influential, being ambitious; α =.83), while biospheric values included four items (i.e., respecting the earth, being one with nature, protecting the environment, preventing pollution; α =.89). A description of the corresponding value was provided for each item. A sample of the questionnaire used is available in appendix E.

6.4. Results

6.4.1. Preliminary Analyses

Before fitting the structural equation model, an examination of both the measurement model and structural model was performed. In this step, the external model of the framework was assessed, evaluating measurement items that collectively constitute a latent variable. The examination of the measurement model entails the assessment of both convergent and discriminant validity.

Convergent validity is defined as the degree to which measuring items associated with a construct demonstrate interrelatedness among themselves (Carlson & Herman, 2012). In the current investigation, this construct is evaluated through different indicators: factor loadings and composite reliability (CR). Cronbach's alpha was considered for scales that have more than three items, while Spearman Brown for two-item scales (Eisinga et al., 2013). A summary of every scale and corresponding indicators is provided in Table 7.

To obtain factor loadings of the different items, a confirmatory factor analysis was conducted. While Comrey and colleagues (1992) highlighted how factor loading should be interpreted without fixing a rigid cut-off, they also provided a minimum range of loadings for an item to be considered part of the corresponding scale. Following the authors' instructions, factor loadings that respect the following criterion "$\lambda > .45$" were included. As shown in Table 7, every item surpasses this threshold.

In interpreting the Composite Reliability, the guidelines established by Heir and colleagues (2013) were followed, that set a criterion of $0.60 < CR < 0.90$. As depicted in Table 7, the composite

reliability for each scale falls within this specified range. Proximity (r = 0.60) and the gain goals (α = 0.61) scales exhibit relatively low reliability scores. On one hand, as pointed out by Eisinga and colleagues (2013), it is common that two-item scales display low reliability scores, which could explain the reason behind the proximity score. On the other hand, although the gain goals scale has been utilized in diverse contexts (Tang et al., 2020), its application in an e-waste recycling research setting is novel. This may offer insights into why a suboptimal score was obtained. Given these considerations and the fact that some scholars set the reliability threshold at 0.60 (Shi et al., 2012), the reliability score was deemed acceptable.

Table 7. Convergent Validity, including scale factor loadings, Chronbach's alpha, and CR

Constructs	Items	Factor Loadings	Chronbach's alpha[1]	Composite Reliability
Proximity	PROX1	0.811	0.60	0.62
	PROX2	0.520		
Availability	AVA1	0.950	0.86	0.88
	AVA2	0.956		
	AVA3	0.587		
User Experience	UE1	0.757	0.87	0.88
	UE2	0.899		
	UE3	0.896		
	UE4	0.662		
Convenience of the collection center	PROX	0.818	0.89	0.83
	AVA	0.714		
	UE	0.837		
Gain Goals	GG1	0.745	0.61	0.60
	GG2	0.659		
	GG3	0.557		
Normative Goals	NG1	0.787	0.74	0.76
	NG2	0.849		
	NG3	0.486		
Hedonic Goals	HG1	0.856	0.87	0.87
	HG2	0.900		
Egoistic Values	EV1	0.730	0.83	0.82
	EV2	0.562		
	EV3	0.865		
	EV4	0.752		
	EV5	0.512		
Biospheric Values	BV1	0.882	0.89	0.88
	BV2	0.895		
	BV3	0.857		
	BV4	0.841		
Hedonic Values	HV1	0.769	0.79	0.78
	HV2	0.726		
	HV3	0.733		
E-waste recycling behaviors	BEH1	0.742	0.85	0.84
	BEH2	0.792		
	BEH3	0.832		
	BEH4	0.767		
	BEH5	0.504		
	BEH6	0.454		

Note. [1]Spearman-Brown coefficients are displayed for 2-item scales.

Discriminant validity is the extent to which items pertaining to a given construct demonstrate a lack of association with the measuring items of other constructs (Bagozzi et al., 1979). In the present study,

discriminant validity was assessed by using the CI_{CFA}(sys) technique, which is based on calculating the confidence intervals (CIs) in confirmatory factor analysis. The upper limits of CI were calculated by using formula 1 (Rönkkö & Cho, 2022). According to the authors, reasonably there is no discriminant validity problem if the $CI_{UL} < 0.8$. As shown in Table 8, data display an acceptable discriminant validity. Table 9 displays the correlations between the study's variables.

$$CI = x + 1.96 \times se \quad CI = x + 1.96 \times se$$

where x = covariance between two constructs, and se = standard error.

Table 8. Discriminant Validity (CI_{CFA}sys) of the study variables

	PROX	AVA	UE	CONV	GG	NG	HG	HV	EV	BV	BEH
PROX	1										
AVA	0.699	1									
UE	0.778	0.677	1								
CONV	0.645	0.613	0.714	1							
GG	0.432	0.273	0.378	0.345	1						
NG	0.572	0.466	0.594	0.553	0.424	1					
HG	0.390	0.374	0.503	0.487	0.314	0.755	1				
HV	0.338	0.230	0.299	0.282	0.054	0.348	0.341	1			
EV	0.308	0.112	0.159	0.198	0.278	0.157	0.051	0.426	1		
BV	0.324	0.265	0.310	0.378	0.339	0.478	0.379	0.454	0.073	1	
BEH	0.515	0.399	0.340	0.467	0.348	0.428	0.306	0.137	0.215	0.216	1

Note. Coefficients represent confidence intervals' upper limits per each pair of variables. PROX = Proximity to the collection center; AVA = Availability of the collection center; UE = User experience of the collection center; CONV = Convenience of the collection center; GG = Gain goals; NG = Normative Goals; HG = Hedonic goals; EV = Egoistic values; BV = Biospheric values; HV = Hedonic values; BEH = e-waste recycling behaviours.

Table 9. Bivariate correlations between study variables

	CONV	GG	NG	HG	HV	EV	BV	BEH
CONV	1							
GG	-.61**	1						
NG	.59**	-.28***	1					
HG	.43**	-.27***	.57***	1				
HV	.26**	-.01	.18***	.26***	1			
EV	.09*	.12**	-.01	.08*	.32***	1		
BV	.27**	-.20***	.31***	.28***	.32***	.04	1	
BEH	.42**	.30***	.26***	.20***	.03	-.08*	.10**	1

Note. CONV = Convenience of the collection center; GG = Gain goals; NG = Normative goals; HG = Hedonic goals; EV = Egoistic values; BV = Biospheric values; HV = Hedonic values; BEH = e-waste recycling behaviors.

* p < .05; ** p < .01; *** p < .001

6.4.2. Model Fit and Hypotheses testing

Structural equation model fitting was conducted using Mplus. A Bayesian estimator was used. Missing data was handled by using full-information maximum likelihood estimation. First, model fit was assessed by interpreting CFI and RMSEA indicators. Hu and Bentler (1999) recommend using cut-off values close to .95 and .05 for CFI and RMSEA respectively, as they result in the least sum of type I and type II error rates. The model shows that CFI = 0.933 while RMSEA = 0.044. The model thus shows a generally acceptable model fit rate.

Second, the hypotheses were tested. Findings align partially with the first three hypotheses, demonstrating that e-waste recycling behaviours are influenced by gain (β = -0.304, $p < .001$) and normative goals (β = 0.154, $p < .05$), while hedonic goals show no significant impact (β = -0.064, $p > .05$). Therefore, *H1* and *H2* find support, whereas *H3* is rejected. Consistent with expectations, egoistic values positively correlate with gain goals (β = 0.231, $p < .001$), biospheric values significantly impact normative goals (β = 0.190, $p < .001$), and hedonic values exhibit a positive association with hedonic goals (β = 0.146, $p < .001$), supporting *H4, H5,* and *H6.*

In accordance with goal framing theory, the study reveals that convenience to collection centres is a situational factor directly influencing e-waste recycling behaviours ($\beta = 0.166$, $p < .05$), normative ($\beta = 0.565$, $p < .001$), and hedonic goals ($\beta = 0.432$, $p < .001$). Thus, *H8, H9,* and *H10* are confirmed. Contrary to the hypotheses, a negative directionality of convenience toward gain goals was observed ($\beta = -0.602$, $p < .001$), rejecting *H7*. The detailed path coefficients are summarized and compared with previous research in Table 10 and figure 8.

Table 10. Summary of the results and corresponding hypothesis testing

No.	Hypothesis	Path Coefficient (β)	Previous research	Previous research fields	Remarks
H1	GG → BEH	-0.304***	Dogan et al., 2011; Keizer, 2014; Onwezen, 2023	Car usage; Eating Habits	Supported
H2	NG → BEH	0.154*	Dogan et al., 2011; Keizer, 2014; Chakraborty et al., 2017	Car usage; Recycling	Supported
H3	HG → BEH	-0.064	Dogan et al., 2011; Keizer, 2014; Rezvani et al., 2018	Car usage	Not supported
H4	EV → GG	0.231***	Steg et al., 2012	Eating habits	Supported
H5	BV → NG	0.190***	Steg et al., 2012	Eating habits	Supported
H6	HV → HG	0.146***	Steg et al., 2012	Eating habits	Supported
H7	CONV → GG	-0.602***	Abrahamse and Steg, 2009; Hahnel et al., 2014	Responsible energy usage; Car usage	Not supported
H8	CONV → NG	0.565***	Hahnel et al., 2014	Car usage	Supported
H9	CONV → HG	0.432***	Hahnel et al., 2014	Car usage	Supported
H10	CONV → BEH	0.166*	Zhang et al., 2019; Arain et al., 2020	E-waste recycling	Supported

Note. CONV = Convenience of the collection center; GG = Gain goals; NG = Normative goals; HG = Hedonic goals; EV = Egoistic values; BV = Biospheric values; HV = Hedonic values; BEH = e-waste recycling behaviors.

* $p < .05$; ** $p < .01$; *** $p < .001$

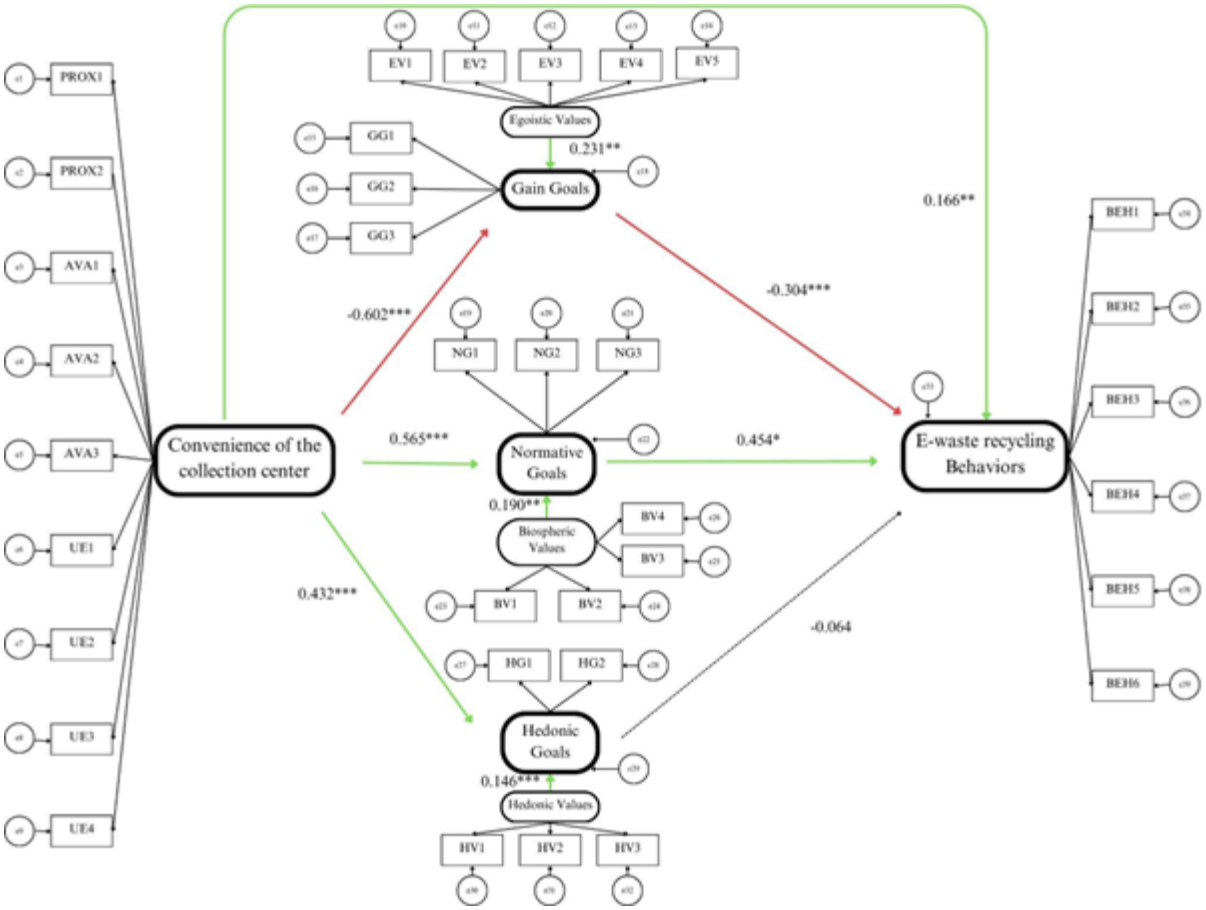

Figure 8. Graphical Representation of path coefficients results

6.4.3. Uncertainty and Sensitivity Analyses

According to Goffart and colleagues (2017), uncertainty analysis was performed to assign confidence bounds to the model predictions. Specifically, the 95% credible/confidence interval of the parameter estimates was computed and reported in Table 11. In addition, uncertainty and sensitivity analysis was performed by comparing the parameters estimates of the tested model to (1) the parameter estimates of a model using the Metropolis-Hastings algorithm (instead of the Gibbs sampler algorithm); (2) the parameter estimates of a model using a higher quality of precision with which the estimates are approximated (Zitzmann & Hecht, 2019); specifically, an Effective Sample Size (ESS) of 400 samples implies a Potential Scale Reduction (PSR) value of 1.002 was used; (3) a model using robust maximum likelihood parameter estimates (MLR); (4) a model using a MLR estimator and multiple imputation approach ($N = 10$) to handle missing data (instead of a full information approach).

When using the Metropolis-Hastings algorithm, a higher quality of precision with which the estimates are approximated, a MLR estimator, and a MLR estimator and multiple imputation (Table 11), the analyses revealed similar parameters estimates.

Table 11. Results of uncertainty and sensitivity analyses

Hypothesis	Tested model		Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]	
	β	95% CI	*β*	95% CI	*β*	95% CI	*β*	95% CI	*β*	95% CI
H1: GG → BEH	-.304	-.43, -.18	-.294	-.43, -.17	-.304	-.44, -.17	-.305	-.42, -.19	-.313	-.43, -.20
H2: NG → BEH	.154	.00, .30	.153	.02, .30	.155	.00, .31	.155	.02, .29	.155	.02, .29
H3: HG → BEH	-.064	-.18, .06	-.058	-.18, .06	-.064	-.19, .06	-.064	-.19, .06	-.066	-.19, .06
H4: EV → GG	.231	.14, .32	.235	.14, .32	.232	.14, .32	.234	.13, .34	.234	.13, .34
H5: BV -> NG	.190	.12, .26	.184	.12, .25	.189	.12, .26	.190	.09, .29	.191	.09, .29
H6: HV → HG	.146	.07, .22	.144	.07, .22	.144	.07, .22	.144	.06, .23	.142	.06, .22
H7: CONV → GG	-.621	-.70, -.54	-.618	-.69, -.53	-.623	-.71, -.54	-.623	-.73, -.51	-.601	-.71, -.49
H8: CONV → NG	.565	.48, .64	.565	.48, .64	.562	.49, .63	.560	.47, .65	.568	.48, .66
H9: CONV → HG	.432	.35, .51	.433	.34, .50	.430	.35, .51	.430	.33, .53	.437	.34, .53
H10: CONV → BEH	.166	.02, .31	.167	.02, .33	.165	.02, .31	.166	.02, .31	.161	.02, .30

Note. CI =credible/confidence interval; CONV = Convenience of the collection center; GG = Gain goals; NG = Normative goals; HG = Hedonic goals; EV = Egoistic values; BV = Biospheric values; HV = Hedonic values; BEH = e-waste recycling behaviors; β = path coefficients; standardized estimates are reported.

[a] Model using the Metropolis-Hastings algorithm Model

[b] Model using a higher quality of precision with which the estimates are approximated

[c] Model with robust maximum likelihood parameter estimates

[d] Model with robust maximum likelihood parameter estimates and multiple imputation (N = 10)

6.5. Discussion

The aim of this study was to investigate the role of situational factors in affecting e-waste recycling behaviours within a goal-framing theory perspective (Lindenberg & Steg, 2007). Specifically, the objective was to analyse the influence of collection centres' convenience (i.e., proximity, availability, and user experience) on e-waste recycling behaviours, both directly and via gain, normative, and hedonic goals. The hypotheses envisioned that convenience related to proximity, availability, and user experience would significantly relate to each goal which, in turn, would affect e-waste recycling behaviours. Convenience would also directly affect behaviours, and egoistic, biospheric, and hedonic values would relate with gain, normative, and hedonic goals, respectively.

Transporting WEEE to the nearest collection centre frequently turns out to be less financially rewarding, more demanding in terms of effort, time-consuming, or labour-intensive than other pro-environmental behaviours (Islam et al., 2021). The results corroborate this statement, revealing that gain goals exhibit a negative influence on the inclination to recycle e-waste (*H1* was confirmed).

This finding is in line with recent research on the influence of goal frames on pro-environmental behaviour. Onwezen (2023) conducted two cross-sectional studies on a sample of 1,100 people and found that gain goal frames were negatively associated with sustainable food consumption, while they promoted price-comparison behaviours when choosing food. Corroborating this study with the findings, arguably recycling e-waste at collection centres is an activity that entails resource depletion, thus resulting in a negative relationship between e-waste recycling behaviours and gain goals. Opting to retain electronic waste at home, selling it to acquaintances, or disposing of it improperly are likely to be more convenient choices, requiring less effort when compared to investing time and incurring transportation costs to reach the nearest disposal service point.

This observation may also account for the unexpected finding of a negative relationship between the convenience of collection centres and gain goals (*H7* was rejected). The convenience, proximity, and accessibility of such services make e-waste recycling a more viable option, conflicting with behaviours associated with maximizing resource goal-frames - such as selling, storing e-waste at

home, or saving gas costs and time to bring e-waste to collection centres. Abrahamse and Steg (2009) assessed households' responsible energy use on a sample of 180,000 people and found that time-consuming behaviours reduce individuals' willpower to perform pro-environmental behaviours (i.e., using energy responsibly).

In line with the hypotheses, convenience situational factors affected e-waste recycling behaviours via normative goals (*H2* and *H9* were confirmed). Past research established this relationship on different pro-environmental behaviour: in a cross-sectional study conducted in the education context, Chakraborty and colleagues (2017) showed that strong normative goals positively shaped university students' pro-environmental behaviour. Arguably, an easily reachable, fast, and efficient e-waste collection service display respect for order from an institution (i.e., the multi-service company responsible for designing recycling processes that benefit the environment), ultimately resulting in an increase of e-waste recycling behaviours. In fact, research shows that convenience of the collection centre is positively related to normative goals because signs of respect for order norms determine goals that prioritize moral obligations (Keizer et al., 2013).

While in contrast with the hypotheses, the absence of a relationship between hedonic goals and e-waste recycling behaviours (*H3* rejected) aligns with past research showing that hedonic goals are not always associated with pro-environmental behaviours (Lindenberg & Steg, 2007). This paper suggests that e-waste disposal is not an environmentally friendly behaviour that promptly enhance individuals' enjoyment, as hedonic goals are not relevant in influencing people's e-waste recycling behaviours. On the contrary, they may be promoted by strengthening normative goals or by making gain and hedonic goals less incompatible with them. Unsurprisingly, the findings of the paper showed that convenience affected hedonic goals to a significant degree (thus confirming *H10*) since an efficient and fast experience fulfils individuals' needs to seek pleasure (Steg et al., 2016).

Ultimately, consistent with goal framing theory framework, the findings reveal a significant and positive association between hedonic, egoistic, and biospheric values with hedonic, gain, and normative goals, respectively (*H4*, *H5*, and *H6* were confirmed). This is consistent with past research,

as Steg and colleagues (2012) conducted four cross-sectional studies to demonstrate that values play a pivotal role in focusing individuals' attention on different goals, contributing to their prioritization. Moreover, as anticipated, this research suggests that convenience directly influences e-waste recycling behaviours (confirming *H7*), in line with previous studies showing the influence of convenience situational factors (Arain et al., 2020).

6.5.1. Limitations of the present study

The present study does not come without its limitations. Firstly, the sample used in this research predominantly comprises older individuals (Mage= 61 years old), potentially limiting the generalizability of findings to a broader demographic. To address this, future research endeavours should purposefully include younger participants, as their distinct attitudes and behaviours toward e-waste recycling may differ significantly. Moreover, a meta-analysis showed that older adults might engage more frequently in pro-environmental behaviours (Wiernik et al., 2016). A new research direction is thus to investigate whether this finding applies for e-waste recycling behaviours as well, thus assessing age differences for this specific pro-environmental behaviour.

Secondly, the research design adopted for this study is cross-sectional, capturing a snapshot of participants' behaviours at a specific point in time. While cross-sectional designs provide valuable insights, they fall short of capturing the dynamic nature of behaviour change. Future investigations should prioritize longitudinal studies to track e-waste recycling behaviours over an extended period. This is a new research direction for e-waste recycling literature, as it would allow for a more nuanced understanding of the factors influencing these behaviours over time, potentially revealing patterns and trends that are not evident in a single-time-point analysis. Furthermore, the findings of the current study may offer some basis for future intervention studies that should test whether an intervention aimed at increasing convenience have an effect on e-waste recycling behaviours.

Thirdly, the reliance on self-report scales to assess both e-waste recycling behaviours and situational factors introduces the potential for response bias and social desirability effects. To enhance

methodological rigor, future research should incorporate different research designs, such as observational or experimental studies, to enable a more objective and controlled examination of the causal relationships between situational factors and e-waste recycling behaviours. This shift toward observational or experimental methodologies would not only strengthen the internal validity of findings, but also facilitate the identification of causal mechanisms that can inform targeted interventions and policy recommendations in the realm of e-waste recycling.

6.5.2. Implications for research and practice

Despite its cross-sectional nature, this research provides new insights into the interplay between convenience and goal framing in the context of e-waste recycling, thus offering some practical implications for improving sustainable e-waste management practices. Firstly, policymakers should strategically plan the distribution of e-waste collection centres, ensuring a comprehensive and capillary network throughout territories. This spatial optimization aims to maximize gain goal-frames, making e-waste disposal more accessible and convenient for individuals, thereby fostering heightened engagement in recycling behaviours.

In addition to spatial optimization, the findings of the current study suggest that availability and user experience are important too. Opening hours of the collection centre might be adapted based on citizens' needs as far as possible. In addition, the design of the collection centre might be developed to meet the citizens' demands and expectations. Finally, companies that organize e-waste management might conduct on a regular basis user experience surveys to obtain feedback and to better identify needs and improve citizens' perceived convenience.

The findings of the present paper also suggest that e-waste recycling is still viewed as an inherently resource-depleting practice, as a negative association between convenience and gain goals was found. Policymakers may want to consider implementing more reward-based systems for citizens that properly dispose of their e-waste, as this might affect gain goals and motivate people to recycle their WEEE to get a reward for it. A progressive tax incentive pricing system based on the weight of waste

has proven effective, even though it may result in illegal dumping by individuals who are reluctant to adhere to the policy (Kirakozian, 2016).

Shevchenko et al. (2019) introduced a recycling incentive mechanism utilizing an electronic bonus card system. The cost of these rewards is distributed among multiple stakeholders, and consumers can redeem the accumulated bonuses to buy remanufactured products. Even though incentive-based systems exist, they are still quite immature (Zhou et al., 2021). It is thus paramount to fine-tune and implement innovative reward-based systems, as this might enhance e-waste recycling behaviours by affecting gain goal frames.

For practitioners, particularly multi-service companies that organize e-waste management practices, there is a clear call to invest in enhancing the user experience of e-waste collection centres. This can be achieved through comprehensive training programs for employees to ensure a knowledgeable and customer-friendly approach. Furthermore, implementing user-friendly technologies and interfaces at the collection centres can facilitate smoother transactions. Additionally, streamlining disposal processes to be fast and efficient can contribute to a positive and hassle-free experience for individuals dropping off their e-waste. By addressing these areas, companies can significantly improve user experience at the collection centre level, encouraging more frequent e-waste recycling behaviours.

Finally, practitioners should collaborate on the development and dissemination of robust communication plans emphasizing the environmental importance of e-waste disposal at collection centres. Such campaigns can help instil a collective sense of normative moral responsibility, showing the potential to reshape public perceptions and behaviours, as well as contribute to more sustainable e-waste management practices. Enhancing normative goals will prove useful to instil a collective sense that e-waste recycling is “the right thing to do” as it benefits the environment and human life. Overall, a collaborative effort between policymakers and practitioners is crucial to establishing an effective, convenient, and user-friendly e-waste recycling infrastructure that aligns with gain goals and societal norms.

To conclude, while psychological factors are undoubtedly important to assess e-waste recycling behaviours (Dhir et al., 2021), this study highlights the paramount importance of assessing situational factors as well, to better encompass behavioural complexity (Canto et al., 2023). Through the application of goal framing theory and the utilization of structural equation modelling in the analysis of survey data from 750 Italian citizens, these results highlighted that gain goals negatively affected e-waste recycling behaviours, while normative goals demonstrated a positive relationship with behaviours. Contrary to expectations, hedonic goals did not exhibit significant relevance in influencing behaviours. This innovative study also suggested that situational factors exert an influence on goals: convenience emerged as a positive factor affecting e-waste recycling behaviours, normative goals, and hedonic goals.

7. Chapter 5: Testing innovative solutions to promote e-waste disposal (Study 3)

Puzzo, G., & Prati, G. Is digital nudging a solution to encourage sustainable e-waste reuse and recycling? An experimental survey.

Submitted to "Electronic Commerce Research" on Friday, 23rd of November 2024.

7.1. Introduction

Our first two studies focused on clarifying the role of internal and external factors in affecting e-waste recycling intentions and behaviours, outlining practical implications to design solutions for enhancing participation in e-waste disposal. In fact, pollution derived from e-waste can be reduced through proper e-waste disposal (Unitar, 2024), but also by giving greater emphasis on the *reuse* principle of circular economy. The *reuse* principle reflects an intensified and extended use of products and their components, while the *recycle* refers to the reprocessing of materials. These principles are crucial in achieving an enhanced and prolonged utilization of products and components, and in closing the loops for raw materials towards the end of a product's life cycle (Zeiss et al., 2020).

Nudging could encourage consumers to reuse and recycle e-waste, as it would assist them in the decision-making process by adjusting the context in which decisions are made (Thaler & Sunstein, 2009). Nudging assumes that human beings are usually susceptible to context-dependent heuristics and biases. A "nudge" is defined as a stimulus that helps people without compulsion, but "gently pushes" them towards the "right choice" (Adkisson, 2008). The widespread adoption of digital technology has led to a growing emphasis on investigating how consumers make choices in digital spaces (Hagberg et al., 2016). Consequently, many decisions on recycling and reuse are now commonly taken online, such as how to dispose of e-waste (Wang et al., 2019) and purchasing "second-hand" refurbished electronics through e-commerce platforms (Zhang et al., 2019).

The literature offers a plethora of nudges that can be implemented in these contexts (Hausmann & Welch, 2010). Zimmerman and colleagues (2021) classified different types of digital nudges in four different categories reflecting the time of application: before, during, after and throughout the action.

While these nudges have been extensively studied in various contexts, such as food (Berger et al., 2020), mobility (Schrills et al., 2020), and energy (Cappa et al., 2020), their effectiveness in enhancing sustainable behaviour is still deemed to be unclear (Zeiss et al., 2020). Moreover, Berger and colleagues (2022) advocated for further investigations of Digital Nudging in contexts that are currently neglected by the literature – such as e-waste recycling and online refurbished product purchase. The authors pointed out that there is currently little research on the effectiveness of Digital Nudging techniques "after action" (e.g., social comparison feedback).

Therefore, the third study of this thesis aims to bridge these gaps by testing the effectiveness of an innovative solution (i.e., digital nudging). We explored the effect of the social comparison feedback - an "after action" digital nudge (Zimmerman et al., 2021) - on people's online choices to buy more refurbished products and to recycle their old ones. Our results will prove useful for governments and businesses alike as they will inform on the effectiveness of a potential digital nudging technique to enhance sustainable e-waste consumption behaviours. We will first outline the relevant theory and literature on digital nudging and on its effectiveness on sustainable behaviour, as well as e-waste recycling and e-products online purchase. We will then describe our experimental design and analysis methodology. Finally, we will discuss our results and point out limitations of our study as well as the practical implications of our findings.

7.2. Theoretical Background

Nudging refers to techniques for influencing behaviour in a predictable manner by adjusting the environment, all without restricting freedom of choice or increasing the effort, time, or other costs associated with alternatives (Hansen & Jespersen, 2013; Thaler & Sunstein, 2009; Hausmann & Welch, 2010). This principle is rooted in the dual-process theory of behavioural economics (Wason & Evans, 1974), which posits that human decision-making can be classified into an intuitive, automatic thinking system (referred to as System 1) and a reason-based, reflective thinking system (System 2) (Stanovich & West, 2000). System 1 handles simple, fast, emotional, and automatic decisions, while System 2 manages slower, rule-based, and more effortful decision-making.

Behaviour arises from decisions made in both reflective and automatic modes of thinking (Kahneman, 2011). In both types of decisions, shortcuts can be employed - also known as cognitive biases or heuristics (Tversky & Kahneman, 1974). While heuristics facilitate quicker decision-making, they can also introduce errors, potentially leading to unfavourable outcomes (Shiv and Fedorikhin, 1999). Thaler and Sunstein (2009) propose that nudges work by counteracting these heuristics and cognitive biases, making them effective for decisions that are typically beyond human cognitive capacity.

In today's increasingly digital landscape, decisions are frequently made within online environments (e.g., websites or apps). People may behave differently in these digital settings compared to analogue environments (Benartzi & Lehrer, 2015; Weinmann et al., 2016). Due to the wealth of information available, digital environments can lead to decision overload, causing people to spend less time focused on reading screens (Liu, 2005). As a result, Weinmann and colleagues (2016) expanded the concept of nudging to encompass digital environments, defining digital nudging as the "utilization of user-interface design elements to steer people's choices or influence users' inputs in online decision environments".

Berger and colleagues (2022) conducted a literature review on digital nudges used to foster environmentally sustainable behaviour in a variety of contexts (i.e., online purchase, water, energy, and mobility choices, Fast-Moving-Consumer-Goods, durable goods, donation). The authors did not find any study aimed at fostering e-waste recycling behaviours. In fact, previous research has primarily focused on industrial decision support systems aiding in the selection of options for recycling end-of-life products (Goggin & Browne, 2000; Staikos & Rahimifard, 2007; Ziout et al., 2014).

However, nudging could indeed be implemented at the end of the product’s in-use stage to help consumers identify suitable end-of-life solutions - such as recycling. An example of this approach can be seen in the UK-based reverse supply chain start-up Stuffstr (2019), which collaborates with apparel retailers like Adidas (2019) to facilitate the repurchase of discarded clothing. Through integration with the online platforms of their partners, Stuffstr encourages consumers to

systematically catalogue their wardrobes at the moment of purchase of new items. In this way, each item in the inventory is assessed, and relevant end-of-life options (e.g., recycle old-clothes materials) are recommended (Zeiss et al., 2020).

Zimmerman and colleagues (2021) classified different types of digital nudges in four different categories reflecting the time of application: before, during, after and throughout the action. Nudges that occur during-action are the most implemented and researched ones (Berger et al., 2022). Folkvord and colleagues (2020) conducted an experimental study aiming to investigate the effect of simplification nudges (i.e., labels that reflect financial benefits or an environmentally sustainable product) for durable goods like electric cars. They found that both labels highlighting financial benefits, such as reduced taxes, and environmental impact influence consumers' choices. However, labels emphasizing financial benefits tend to be more effective than those focusing on environmental aspects.

While these results are promising, no study has tested the effect of after-action nudges on decisions to buy refurbished electronic products or to recycle e-waste. For instance, Social Comparison Feedback (SCF) is an after-action nudge in which consumers receive information on their peers' behaviour (Zimmermann et al., 2021). SCF reflects the social norms bias (Cialdini et al., 1990), as nudges leverage on heuristics to influence behaviour (Schneider et al., 2019). Social norms refer to an individual's beliefs regarding the typical and accepted behaviour in a specific situation (Kormos et al., 2015). Two types of norms are recognized: on one hand, injunctive norms delineate a socially endorsed course of action – such as a bar chart indicating individuals' weekly energy consumption to the average consumption of similar households. On the other hand, descriptive norms outline what is commonly done (e.g., after an online purchase, showing a message stating "57.23% of people buy a second-hand mobile phone" (Cialdini et al., 1990; Kroll et al., 2019).

Summing up, the literature thus shows two important gaps: on one hand, there is no study that assesses digital nudges effectiveness within the e-waste field. On the other hand, currently no research has ever investigated the effectiveness of after-action digital nudges, focusing on during-action ones

(Berger et al., 2022). Therefore, the present experimental study aims to bridge these gaps by testing the effect of SCF after-action nudges (i.e., pop-up claims) on people's choices to buy refurbished electronic products and to recycle their old ones. Pop-up claims are a digital nudging technique operationalized in messages that appear after decision-making (Zimmerman et al., 2021) regarding the purchase of second-hand smartphones and the recycling of their old ones. The analyses will be conducted by controlling for several variables, such as age, gender, price, and quality of the refurbished phone. Taking into account the reviewed literature, we thus hypothesize that:

H1: On average, participants will purchase second-hand electronic products more frequently in the "Nudge" condition compared to the "Control" condition.

H2: On average, participants will choose to recycle their product more frequently in the "Nudge" condition compared to the "Control" condition.

7.3. Materials and methods

7.3.1. Sample description.

We have conducted a power analysis to define the necessary sample to ensure statistical reliability. To the authors' knowledge, this is the first scientific attempt to test after-action nudges in the field of phone reuse and recycling. Therefore, we have taken into consideration a paper that shares similar objectives (Schultz et al., 2015) to conduct the power analysis. We have considered Cohen's d effect size of the group subject to social norms nudge, which is a medium-small effect size (d = .32) (Cohen, 1988). For the power analysis we thus expect to have a medium-small effect size (w = .15) (Cohen, 1988). The analysis was conducted by using Gpower v3.1 and resulted in 350 people. The questionnaire was disseminated through snowball sampling, leveraging on the professional network of the researchers and shared on social networks such as Instagram, LinkedIn, Whatsapp, Telegram and Facebook. The questionnaire remained active for one month between February and March 2024.

7.3.2. Experimental design

The research followed an experimental survey design. The online questionnaire (developed via Qualtrics) lasted 5 minutes to minimize questionnaire fatigue. Participants in the study read the informed consent form and, by continuing with the questionnaire, gave their consent to participate. Participation was voluntary and could be withdrawn at any time without consequences. The Qualtrics algorithm randomly assigned participants to two groups: the Nudge group and the control group. The questionnaire consisted of several sections: 1) purchase section 2) recycling section 3) attitudes and social desirability 4) socio-demographic information. The next paragraphs describe in detail each section of the survey.

7.3.2.1. Purchase Section

To reduce biases, participants were asked to choose the price range they usually consider for purchasing a mobile phone between three alternatives. Price ranges were defined according to Boyer and colleagues' (2021) taxonomy: less than 450 euros; 450-600 euros; more than 600 euros. Depending on their choice, participants were redirected to the corresponding questionnaire section: for example, if they indicated a price range between 450 and 600 euros, participants were redirected to a version of section 1 presenting phones with prices within the selected range.

In the first stage, participants were asked to choose which phone to buy from two alternatives, displaying similar colour features and price. The prices of the phones were based on real prices on the "amazon.it" e-commerce platform for the phone models described in table 12 as of November 28, 2023. The price difference between the two similar phones was justified by the presence of a better camera. Following the average price difference between investments in smartphone cameras (Statista, 2022c) the two similar phones always had a price difference of approximately 20 euros.

Table 12. Phone models considered to define phone prices per survey question

Price Range	Question number	Phone Model
Less than 450 euros	Q1	Xiaomi Redmi Note 11 Pro 5G
	Q2	Samsung Galaxy Note 8
	Q3	Oppo find x2 lite
	Q4	Motorola edge 30 neo
Between 450 and 600 euros	Q1	One plus nord 3
	Q2	Xiaomi 12
	Q3	Samsung Galaxy S20 Ultra 5G
	Q4	Huawei p30 pro
More than 600 euros	Q1	Apple iphone 14
	Q2	Apple iphone 15
	Q3	Xiaomi 13t pro
	Q4	Samsung galaxy s21 ultra 5g

Once they made this decision, in the second stage participants were given the opportunity to purchase the refurbished version of the same mobile phone they chose. A "pop-up claim", based on real data from Statista.com, appeared at this stage for the Nudge group (e.g., "In Europe, the number of people buying a used phone will increase by 60% by 2025."). The control group did not see any nudges. Both groups were also shown the product and the price of the refurbished phone. Considering that the market repositioning costs of a used phone correspond on average to 60% of the new counterpart (Dowlatshahi, 2000; Steinhilper, 2003), the price of the refurbished phone was equivalent to 60% of the price of the new phone initially chosen by the participants (e.g., Singhal et al., 2019; Wang et al., 2019). Participants repeated the two stages of the purchase section 4 times, where they evaluated the purchase of a refurbished product with different quality ranges presented randomly. Figure 9 and Figure 10 show examples of the two stages of the purchase section.

Figure 9. Example of Stage 1 of the purchase section

Figure 10. Example of Stage 2 of the purchase section.

Following the methodological example of other studies (Boyer et al., 2021), the different qualities of the used phone were derived based on the quality categories used on 3 Italian e-commerce sites (www.rebuy.it; www.ricompro.it; www.cellulariusati.net). In particular: a) Good as new: showing no or minimal signs of use; b) Very good: may show possible slight signs of use; c) Good: may show some possible signs of use; d) Acceptable: may show possible evident signs of use, but no breakage or damage.

7.3.2.2. Recycling Section

Participants were asked to imagine having purchased a new mobile phone and needing to dispose of the old one. For the Nudge group, a "pop-up claim" also appeared (e.g., Every year, more than 315 million people recycle their electronic products in Europe when they purchase a new product). The

control group did not see any nudges. After that, participants chose how they wanted to dispose of their old product from 5 alternatives: 3 were recycling options, while 2 were non-recycling options. Recycling options stemmed from the informative website of the multiservice organization that manages e-waste in the region where the study was conducted. The first recycling option was to reuse the phone (i.e., giving it to an acquaintance or to bring it in a "reuse station" where people can take it for free). The second option was to bring the phone to a recycling station (i.e., where the phone would be dismantled, and its critical raw materials recovered). The third option was to take it to a retailer (i.e., where it would be disposed correctly). Non-recycling options were to either put the phone in a drawer and think about recycling in the future or to not recycle it.

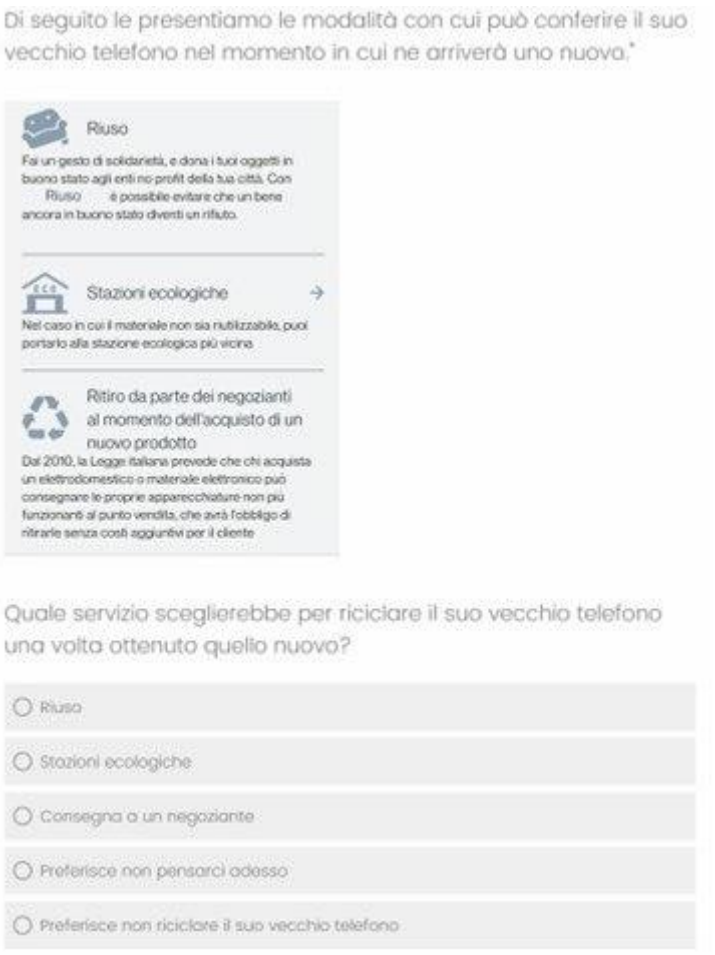

Figure 11. Recycling section

7.3.2.3. Attitudes and social desirability

In the third section, participants completed the scale of attitudes towards e-waste recycling (Koshta et al., 2022) and the reduced version of the social desirability scale (Rattazzi et al., 2000).

Attitudes towards e-waste recycling. Attitudes towards e-waste recycling were measured by adapting four items from the scale used by Koshta and colleagues (2022). Participants were asked to rate on a 5-point Likert scale (ranging from 1 = Definitely disagree to 5 = Definitely agree) how much they agreed with 4 statements on e-waste recycling. Example items are: "Recycling e-waste makes you feel satisfied"; "Recycling e-waste is good for the environment" ($\alpha = 0.80$).

Social Desirability. Social Desirability was measured by using the reduced version of the social desirability scale (Rattazzi et al., 2000). Participants were asked to decide whether each of nine statements were true or false for what concerns themselves. Each response was interpreted according to the scoring key by Marlowe & Crowne (1960) and given a score ranging from 1 to 9. Example items include: "I've never said on purpose something that might hurt someone else's feelings"; "I'm willing to admit when I make a mistake" ($\alpha = 0.73$).

7.3.2.4. Socio-demographic Information

Finally, participants were asked to give out some socio-demographic information (i.e., gender, age, level of education). The data was collected anonymously, and the IP address was not recorded.

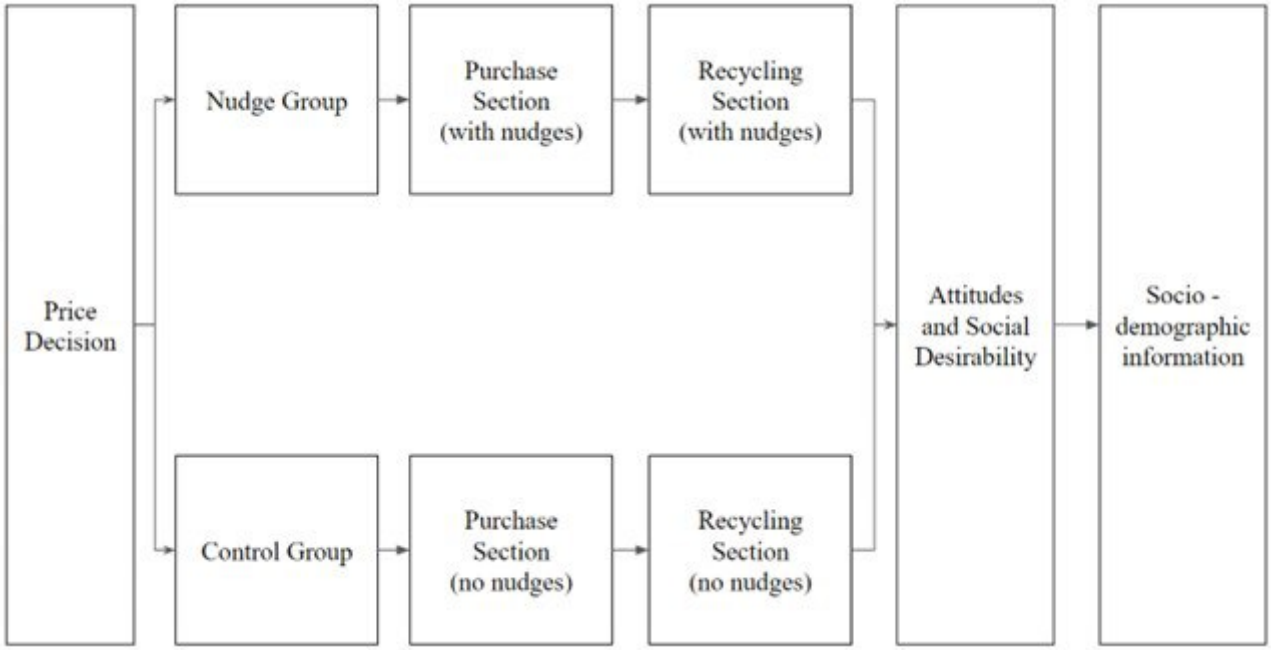

Figure 12. Experimental Flowchart

7.3.2. Analyses

We performed ordinal regression to investigate whether the purchase of the second-hand product was statistically different between the "Nudge" and "Control" groups. We made this choice as the dependent variable is not continuous and it is non-normally distributed. We controlled for the effect of multiple covariates (e.g., Price Range, Quality of the refurbished phone, Attitudes towards e-waste recycling, social desirability, age, gender, and level of education). We also performed a logistic regression to understand whether the dichotomous variable "recycling choices" differed across the nudge groups, using the purchase of refurbished product as a control variable, as well.

7.4. Results

7.4.1. Participant flow

Experimental manipulation was implemented as intended, as 567 people were assigned randomly to one of the two groups (Nudge and Control). 49.4 % of the sample was allocated to the Nudge group (N_{Nudge} = 282). 269 participants of this group began and completed the experiment, while 23 did not fully fill it. The total number of participants for the nudge group included for analysis was thus 269.

50.6% of the total sample was assigned to the Control Group ($N_{Control}$= 285). 265 participants of this group began and completed the experiment, while 20 did not. The total number of participants for the control group included for analysis was thus 265. Summing up, 43 people began but did not complete the experiment, leading to a total sample size of 524 participants.

Table 13. Participant Flowchart

Method
Random Assignment Method
Participants were randomly assigned to either the nudge or the control group after choosing their price range. Once they were assigned to a group, participants could not switch to the other.
Random Assignment Implementation and Concealment
The researchers designed the experimental flowchart and assignment sequence.Participants were enrolled by leveraging on the researchers' professional network via LinkedIn, Instagram, Whatsapp and Telegram. Participants were randomly assigned to the groups by the Qualtrics software algorithm.
Masking
Participants were not aware of the condition assignments. This research complies with ethical standards and obtained ethical approval by the University of Bologna.
Statistical Methods
We performed ordinal regression to investigate whether the purchase of the second-hand product was statistically different between the "Nudge" and "Control" groups. We also performed a logistic regression to understand whether the dichotomous variable "recycling choices" differed across the nudge groups.

7.4.2. Baseline Data

The average age of the sample was 41 years old (SD_{age} = 14.3). 47.6% of the sample identified as woman, 49.2% as man, 0.2% as transgender, 1.6% as non-binary, and 1.4% preferred not to display their gender. Regarding the level of education, 36.4% of the sample reported having a master's degree

as their higher title. Detailed frequencies for these socio-demographic variables can be found in table 14.

Table 14. Socio-demographic frequencies

Categorical Variable	**Frequencies**
Gender	Women: 243 (46.4%)
	Men: 251 (47.9%)
	Transgender: 1 (0.2%)
	Non-binary: 8 (1.5%)
	Prefer not to answer: 7 (1.3%)
	Missing: 14 (2.7%)
Age	18-25: 49 (9.4%)
	26-35: 201 (38.4%)
	36-45: 76 (14.5%)
	46-55: 63 (12.0%)
	56-65: 100 (19.1%)
	66+: 20 (3.8%)
	Missing: 15 (2.9%)
Level of Education	Middle School: 13 (2.5%)
	High School: 154 (29.4%)
	Bachelor's degree: 87 (16.6%)
	Master's degree: 191 (36.4%)
	PhD: 42 (8.0%)
	Foreign education: 5 (1.0%)
	Postgraduate school: 18 (3.4%)
	Missing: 14 (2.7%)

Regarding the price range, 55.9% of the participants reported to usually buy phones within the "Less than 450 euros" price range, 19.3% considered phones "Between 450 and 600 euros", while 24.8% selected to purchase products that cost "More than 600 euros". Regarding recycling options, 43.7% of the respondents reported to prefer reusing their old phone (i.e., bringing it to a "reuse station" or giving it to an acquaintance), 15.5% to bring it to a collection centre, while 20.6% chose to give it to their retailer. These responses were coded as "Recycling choices". 4.6% of the sample reported to prefer not thinking about phone recycling, while 15.6% preferred not to recycle their old phone. These responses were coded as "Non-recycling choices" In total, 366 respondents (79.8%) selected recycling options for their old phone, while 163 people (20.2%) did not. Frequencies of recycling choices across the two experimental groups can be found in table 15.

Table 15. Recycling choices across Nudge and Control groups

Recycling options	**Nudge group (N = 259)**	**Control group (N = 265)**
Recycling choices	210 (81.0%)	208 (78.4%)
Reuse	111 (43.7%)	118 (44.5%)
Collection Center	40 (15.5%)	41 (15.5%)
Retailer	59 (20.6%)	49 (18.5%)
Non-Recycling choices	49 (19.0%)	57 (21.6%)
Prefer not to think about it	13 (4.6%)	11 (4.2%)
Prefer not to recycle it	36 (15.6%)	46 (17.4%)

7.4.3. Descriptive statistics and Analyses of Variance results

7.4.3.1. Used phones purchase

Used phones purchased were computed by coding the responses where participants did not choose to buy a refurbished phone as "0". Responses where participants chose to buy a used phone were coded as "1". A new quantitative variable called "Used phones purchase" was then created by summing the

responses of each participant (e.g., if a participant chose 2 times to buy a refurbished phone, they scored "2" for the "used phones purchase" variable).

The Ordinal regression revealed a significant effect of age on used phones purchase (β = -.017, p < .001). Gender did not show a significant effect on used phone purchase (β = .148, p = .051). Both males and females exhibited similar frequencies of phone purchases. Finally, for what concerns socio-demographic control variables, level of education did not significantly affect used phone purchase (β = -.022, p = .527). Variation in educational backgrounds did not correlate with differences in phone purchasing behaviour.

Regarding experimental control variables, neither price range (β = -.065, p = .277) nor quality (β = .154, p = .094) significantly influenced used phone purchase. Consumers did not demonstrate distinct purchasing patterns based on perceived price or quality of phones. Attitudes towards e-waste recycling significantly influenced used phone purchase (β = ,274, p < .001). Positive attitudes towards e-waste recycling were associated with increased phone purchases. Similarly, social desirability had a significant effect on used phone purchase (β = -0.058, p = .021). Individuals with high social desirability were proclived to buy refurbished products less frequently. Moreover, we found no significant difference in used phone purchase between the nudge group and the control group (β = .021, p = .835). It seems that the presence of nudges did not affect the purchasing behaviour of participants.

7.4.5.2. Recycling choices

The Logistic Regression for recycling choices revealed that participants' age demonstrated a statistically significant effect on recycling choice (β = -.021, p = .027). This suggests that age plays a role in influencing individuals' decisions regarding recycling behaviour. Gender, on the other hand, did not show a significant effect on recycling choice (β = .086, p = .555). Gender differences thus did not appear to significantly impact recycling behaviour in this study. Surprisingly, the level of education significantly influenced recycling choice (β = -.172, p = .038). This indicates that

individuals with different educational backgrounds may have varying preferences or priorities when it comes to recycling.

Focusing on experimental control variables, participants' preferred price range significantly affected recycling choice (β = .047, p = .047). This suggests that people that tend to buy cheaper phones display a proclivity to recycle their old ones. The quality of the used phone did not affect recycling choices (β = .372, p = .082), and the same applies to Social Desirability (β = -.085, p = .131) and Attitudes (β = -.226, p = .137). It appears that quality of the used phone, attitudes towards e-waste recycling, and social desirability may not be significant drivers of recycling behaviour in this context. Quite the opposite, used phones purchased demonstrated a highly significant effect on recycling choice, (β = 0.356, p < .001). This suggests that the more frequently people buy used phones, the more they are inclined to recycle their old products. Finally, there was no significant difference in recycling choice between the nudge group and the control group (β = .081, p = .728). This indicates that the experimental nudge group did not have a significant impact on participants' recycling behaviour compared to the control condition. Table 16 shows the ordinal and logistic regressions' results in detail.

Table 16. Ordinal Regression Results for Used Phones Purchased

Parameter	Parameter Estimates						
						Confidence Interval 95%	
	Odds *(β)*	S.E.	Wald's $\chi 2$	*df*	*p*	LL	UL
Used Phones Puchased							
Threshold [rating score = 0]	-0.80	0.481	0.028	1	0.867	-1.023	0.862
[rating score = 1]	0.348	0.480	0.526	1	0.468	-0.563	1.290
[rating score = 2]	0.723	0.480	2.265	1	0.132	-0.219	1.664
[rating score = 3]	1.103	0.481	5.263	1	0.022	0.161	2.046
Covariates							
Age	-0.17	0.004	18.377	1	<.001	-0.24	-0.009
Gender	0.148	0.076	3.797	1	0.051	-0.001	0.296
Level of Education	-0.022	0.034	0.420	1	0.517	-0.088	0.044
Price Range	-0.065	0.060	1.181	1	0.277	-0.183	0.052
Average Quality	0.154	0.092	2.798	1	0.094	-0.026	0.335
Attitudes	0.274	0.071	14.859	1	<.001	0.135	0.414
Social Desirability	-0.058	0.025	5.346	1	0.021	-0.108	-0.009
Group	0.021	0.102	0.043	1	0.835	-0.179	0.221

Table 17. Logistic Regression Results for Recycling options

Predictor	***β***	**S.E. *β***	**Wald's $\chi 2$**	***df***	***p***	**Exp (*β*)**
Constant	1.369	0.110	153.934	1	<.001	0.254
Group	0.081	0.232	0.121	1	0.728	1.084
Age	-0.21	0.009	0.4914	1	0.027	0.979
Gender	0.086	0.146	0.348	1	0.555	1.090
Level of Education	-0.172	0.083	4.284	1	0.038	0.842
Price Range	0.261	0.132	3.929	1	0.047	1.299
Average Quality	0.372	0.213	3.033	1	0.082	1.450
Attitudes	-0.226	0.152	2.210	1	0.137	0.798
Social Desirability	-0.085	0.056	2.278	1	0.131	0.918
Used Phones Purchased	0.356	0.083	18.324	1	<.001	0.700

Table 18. Bivariate Correlations

Variable	**M**	**SD**	**1**	**2**	**3**	**4**	**5**
1. Age	41.01	14.31	-	-	-	-	-
2. Quality of the used phone	2.47	0.56	.048	-	-	-	-
3. Attitudes	4.35	0.71	.089*	.024	-	-	-
4. Social Desirability	4.75	2.20	.327***	.055	.006	-	-
5. Used phones purchased	1.69	1.61	-.251***	.064	.115**	.141**	-

7.5. Discussion

The present experimental study aimed to test the effect of an “after action” digital nudge (i.e., social comparison feedback; Zimmerman et al., 2021) on people’s online choices to buy more refurbished products and to recycle their old ones. We hypothesized that participants would have purchased second-hand electronic products more frequently in the "Nudge" condition compared to the "Control" condition (*H1*). Moreover, we hypothesized that participants would have chosen to recycle their product more frequently in the "Nudge" condition compared to the "Control" condition (*H2*).

Our results did not support our hypotheses, as participants in both groups purchased used phones and recycled their old ones at the same extent. On one hand, used phones purchased do not significantly change between the nudge and the control group (*H1* is rejected). Moreover, people in the nudge group did not choose to recycle their old product more frequently than those belonging to the control group (*H2* is rejected). While “before action” and “during action” digital nudges’ effectiveness is well documented (Zimmerman et al. 2021; Berger et al., 2022), our study is the first one in the literature to assess the effectiveness of “after action” digital nudges. Our findings display that digital nudges that are enacted after action (in this case, choosing which product to buy) are not effective neither in “gently pushing” people to buy refurbished phones nor to recycle their old products.

The regression analyses show that other factors might be more influential in fostering used phone purchases and e-waste recycling. The mean phone purchases differed across age groups, with the data indicating that as individuals' age decreased, their used phone purchases and choice to recycle their old phone increased. This finding is in contrast with previous research showing that older people engage in pro-environmental behaviour more often than younger generations (Wang et al., 2021). Our findings can be interpreted in several ways. One possibility is that younger individuals may be more inclined to purchase more used phones due to a desire to pay less to stay up-to-date with the latest devices. On the other hand, older individuals may purchase used phones less frequently as they do not perceive this behaviour as being important for the environment: as shown by previous studies

(Cheung et al., 2015), older people are less knowledgeable about environmental issues than younger generations.

In line with previous research (Meyer et al., 2015; Wang et al., 2022), we found that people with higher levels of education chose more frequently to recycle their old phone. This implies that higher levels of education could be associated with greater environmental awareness, knowledge of recycling practices, or a stronger commitment to sustainable behaviours, thus leading to choosing to recycle one's old phone when buying another. Conversely, individuals with lower levels of education may have limited access to information about recycling initiatives or may prioritize other considerations over environmental concerns. It is also worth noting that gender did not emerge as a significant predictor of recycling choice in this study, suggesting that recycling behaviour may not be strongly influenced by gender differences within the context examined. This finding contrasts with previous research (Hunter et al., 2004), suggesting potential gender disparities in environmental behaviours but underscores the need for further investigation into the interplay between gender and e-waste recycling practices.

Moreover, the findings suggest that consumers who hold more positive attitudes towards e-waste recycling are more likely to engage in used phone purchases and in recycling choices. This alignment between pro-environmental attitudes and purchasing behaviour may be attributed to several factors. For instance, individuals with strong pro-recycling attitudes may prioritize purchasing used phones as a means of contributing to the reduction of electronic waste accumulation. Alternatively, they may be more inclined to upgrade to more environmentally friendly phone models such as the refurbished ones. Our results also indicate that higher levels of social desirability are associated with a decreased likelihood of purchasing used phones. This finding suggests that individuals who score higher on social desirability may be less inclined to buy used phones, potentially due to concerns about social perceptions or the stigma associated with second-hand goods (Xu et al., 2014). These results contribute to the broader understanding of how social influences can shape consumer behaviours, particularly in the context of sustainability.

Participants who indicated a preference for lower-priced phones demonstrated a greater likelihood of recycling their old devices. It seems that cost-conscious consumers may prioritize sustainability and environmental considerations when making purchasing decisions, leading them to actively participate in e-waste recycling initiatives. Finally, the association between higher used phone purchases and increased likelihood of recycling old devices suggests several possible explanations. Firstly, individuals who regularly purchase used phones may be more environmentally conscious or sustainability-oriented, leading them to prioritize e-waste recycling as part of their consumption habits. Additionally, frequent buyers of used phones may perceive recycling as a responsible and ethical means of disposing of outdated or unused devices, aligning with their values and attitudes towards environmental stewardship. Moreover, this observed relationship underscores the importance of consumer behaviours, specifically purchasing habits, in driving e-waste recycling practices. This highlights the potential for targeted interventions aimed at promoting sustainable consumption behaviours, particularly among frequent purchasers of used electronics.

7.5.1. Limitations of the present study

Like any other research attempt, our study is subject to several limitations. First, the survey's reliance on participants from the professional pool of researchers and snowball sampling may introduce sampling bias, limiting the generalizability of the findings to other populations. This population pool may have unique demographic, socioeconomic, or cultural characteristics that differ from other ones, affecting the external validity of the study. Nevertheless, our socio-demographic analyses displayed how our sample is consistently varied between different age, gender and education groups; therefore, we deem it as sufficiently reliable.

Moreover, while the survey may have examined specific variables such as age, education level, and attitudes towards recycling, it may have overlooked other potentially relevant factors that could influence used phone behaviour and e-waste recycling choices. For example, factors like income level, urban/rural residence, or employment status could also play significant roles but were not

included in the analysis to prevent questionnaire fatigue. Nevertheless, doing a focused and essential survey made it possible to collect a high number of responses.

Surveys are susceptible to measurement errors, including response bias, social desirability bias, and recall bias. Participants may provide inaccurate or socially desirable responses, particularly when reporting sensitive information such as environmental attitudes or recycling behaviours, leading to biased results. That is why we added attitudes and social desirability as our control variables. Finally, while the survey experiment design allows for comparisons between the experimental and control groups, establishing causal relationships between the experimental manipulation (i.e., digital nudge) and outcomes (e.g., recycling behaviour) can be challenging. Factors outside the researcher's control may confound the results, making it difficult to attribute observed differences solely to the experimental intervention.

7.5.2. Implications for research and practice

The findings of this study have several implications for both research and practice in the domains of consumer behaviour and environmental sustainability. First, the study's results challenge the effectiveness of "after action" digital nudges, particularly in influencing consumer choices related to the purchase of refurbished products and e-waste recycling. This highlights the need for further research to explore the conditions under which different types of digital nudges are most effective and to identify alternative strategies for promoting sustainable behaviours.

Moreover, the significant effects of age on both phone purchasing habits and recycling choices underscore the importance of considering demographic factors in understanding consumer behaviour related to electronic devices. Future research could delve deeper into the mechanisms underlying these demographic influences and explore potential interventions tailored to different age groups and educational backgrounds. The study's findings also highlight the significant impact of pro-environmental attitudes on consumer choices regarding used phone purchases. This suggests that interventions aimed at promoting sustainability should focus on cultivating positive environmental

attitudes among consumers. Additionally, sustainability-focused marketing strategies may be particularly effective in appealing to consumers with strong pro-recycling attitudes.

The association between lower price range preferences and increased likelihood of recycling old devices suggests that economic considerations play a significant role in shaping e-waste management behaviours. This implies that interventions aimed at promoting e-waste recycling should consider the economic constraints faced by consumers. Overall, the study underscores the importance of considering the complex interplay between individual characteristics, environmental attitudes, and external influences in shaping consumer behaviour related to electronic devices and e-waste management. Future research could focus on developing multifaceted interventions that target both individual-level factors and broader contextual influences to promote sustainable consumption behaviours effectively.

8. Chapter 6: General Discussion

E-waste is recognized as the world's fastest-growing waste stream, driven by rapid technological advances, increasing electronic device diversity, faster innovation, population growth, urbanization, and falling prices. Constantly evolving consumer preferences lead to frequent electronic replacements with shorter lifespans, exacerbating the e-waste crisis. This crisis poses significant threats to human health, the environment, and the economy due to the improper disposal of e-waste, which releases hazardous substances like mercury, lead, and plastics into the environment. These toxins can cause serious health issues, including thyroid dysfunction, cancer, and damage to various organs. Annually, improper e-waste management releases substantial amounts of mercury and plastics with brominated flame retardants, raising concerns about environmental protection and resource recycling. Although metal recovery and avoided greenhouse gas emissions provide economic benefits, the overall financial impact of e-waste management remains highly negative due to significant treatment and external health and environmental costs.

In 2022, the 62 million tonnes of generated e-waste were disposed of via four main routes: formal e-waste collection systems, residual waste disposal, and informal collection systems with or without developed management infrastructures. Only the first route is the most appropriate, as it is the only method that optimizes the impact on the environment, economy, and human health. For instance, residual e-waste disposal often ends up in household waste bins, particularly in high and upper-middle-income countries. Smaller e-waste items like lamps and IT devices are frequently discarded with regular waste, while larger items may be incinerated or dumped in landfills without recycling, depending on the waste management infrastructure. Some high-income countries use magnet separation or recycle bottom ash from municipal incineration to recover metals, yielding an estimated 80 million kg of metals. However, most metals (7 billion kg) are lost during incineration or landfill disposal. Due to the negative environmental impact and significant resource losses, improper disposal of e-waste is prohibited under most e-waste legislation. Despite this, people worldwide improperly dispose of more than 14 million tonnes of generated e-waste with residual or regular waste.

Therefore, the role of consumer behaviour in preventing e-waste from being improperly disposed of is crucial. Consumer behaviour is the starting point for effective e-waste management, as individuals decide how and where to dispose of their electronic waste. Proper disposal through formal collection systems could significantly increase the environmentally sound management of e-waste. Achieving a 60% e-waste collection and recycling rate by 2030 could yield benefits exceeding costs by over USD 38 billion, including reduced health risks. Understanding consumer intentions and behaviours is essential to mitigating the e-waste crisis's impact on the environment, human health, and the economy. Psychology can help explain why people often neglect proper e-waste disposal despite its significant benefits.

The psychological literature on e-waste recycling currently exhibits three main gaps. Firstly, despite numerous studies employing various theories to investigate the psychological antecedents of e-waste recycling intentions and behaviours, there is no consensus on which factors have the strongest effect sizes and are most likely to influence disposal behaviour (Thukral et al., 2023). Secondly, there is a scarcity of research focusing on the impact of external, situational factors on e-waste recycling behaviours, which exacerbates the intention-behaviour gap in e-waste management practices (Parajuly et al., 2020). Lastly, the literature on WEEE (Waste Electrical and Electronic Equipment) recycling behaviors has struggled to develop practical, rapid, and feasible implications for organizations, with limited efforts to design and test innovative digital nudging solutions to engage consumers in e-waste recycling (Dhir et al., 2021; Stefandotter et al., 2016). Therefore, in collaboration with a multi-service company in the Emilia-Romagna region, this PhD project had three main objectives:

1) To achieve a more robust understanding of the relationship between various constructs predicting WEEE recycling intentions and behaviours through a meta-analysis focused on e-waste (Study 1).

2) To clarify the role of external variables (e.g., convenience of collection centres) in affecting e-waste recycling behaviours, thereby contributing to bridging the intention-behaviour gap (Study 2).
3) To experimentally test the effectiveness of digital nudging on e-waste reuse and recycling intentions and behaviours, ultimately proposing innovative solutions to improve e-waste management practices (Study 3).

The following sections will discuss implications for research and practice stemming from the main results of the three studies of this thesis.

8.1. Recalibrating psychological antecedents of e-waste recycling intentions and behaviours

Psychological antecedents of e-waste recycling intentions and behaviours can either be internal (knowledge, motivation, beliefs, habits, values, attitudes, intentions, and other psychological variables) or external (rewards implications, infrastructure convenience, and institutional constraints) (Parajuly et al., 2020). State-of-the-art studies and researchers have focused more on internal rather than external variables (Islam et al., 2021; Thukral et al., 2023). The meta-analysis conducted in this thesis is the first attempt in psychological literature to encompass every relevant psychological antecedent of e-waste recycling intentions and behaviours and to quantitively synthesize their effect sizes. Despite the preferred focus on internal variables, the meta-analysis shows the prominent role of external variables in affecting e-waste recycling intentions. In fact, out of three variables that display a “very large” effect size, only “attitudes” is an internal variable, while convenience and policy effectiveness are contextual ones. Moreover, “habits” - considered to be one of the most important internal variables that affect e-waste recycling intentions (Thukral et al., 2023), actually displays a non-significant effect size.

8.1.1. Internal variables

Our research findings corroborate the hypothesis that the qualitative assessment of e-waste recycling—whether it is perceived positively or negatively—exerts a more substantial influence on

recycling intentions compared to perceived social pressure or the perceived difficulty of the behaviour. This aligns with the extensive literature highlighting the pivotal role of attitudes in shaping behavioural intentions (Parajuly et al., 2020). Specifically, our results contribute to this body of knowledge by demonstrating that among the variables studied, attitudes exhibit the largest effect size. This contrasts with earlier cross-sectional studies, such as Kumar and colleagues (2017), which posited that subjective norms exert a less significant influence on intentions compared to perceived behavioural control. Our findings indicate that subjective norms, while influential, do not diminish the impact of perceived behavioural control on recycling intentions. This nuanced understanding underscores the importance of fostering positive attitudes towards e-waste recycling to effectively promote sustainable behaviour.

Our study also identified a large and positive correlation between knowledge and intentions regarding e-waste recycling. It appears that e-waste recycling is often perceived as overly complex. Therefore, we argue that understanding fundamental e-waste issues—such as the consequences of failing to recycle e-waste—constitutes a crucial cognitive variable that correlates significantly with recycling intentions. Supporting this, Borthakur and Govind (2019) found in their survey of urban Indian recycling behaviour that 95.8% of residents were unaware of any formal recycling channels. Similarly, Arain and colleagues (2020) revealed in their study of e-waste recycling behaviour at a Midwestern US university that young consumers possess inadequate knowledge about e-waste and its disposal. These findings highlight a widespread lack of consumer awareness regarding the availability of e-waste recycling services and the deficiencies in management programs across various countries. This underscores the necessity of implementing policies aimed at increasing public awareness about formal recycling facilities and methods.

Recycling habits, shaped by past experience, significantly influence consumers' future participation in recycling activities. Prior studies have demonstrated that recycling experience impacts consumers' green practices (Wang et al., 2011; Bouvier & Wagner, 2011; Colesca et al., 2014; Shevchenko et al., 2019). Wang and colleagues (2011) found that recycling habits are crucial in motivating users to

engage in recycling. For any country, initiatives to foster recycling habits among consumers are essential for the long-term development of an effective e-waste management system. Saphores and colleagues (2012) observed similar behaviour among US households, noting that experienced recyclers are more likely to take their WEEE (Waste Electrical and Electronic Equipment) to recycling centres. Dwivedy and Mittal (2013) concluded from their analysis that recycling habits ultimately strengthen an individual's willingness to participate in future recycling efforts.

Our study diverges from previous findings, as we did not detect a significant correlation between habits and intentions. This surprising outcome can be understood through the theoretical framework of our research; habits predominantly affect repetitive behaviours. Since the frequency of a behaviour is linked to the strength of a habit (Klockner, 2013), habits tend to have a weak association with behaviours that occur infrequently (Triandis, 1980). This is further supported by a meta-analysis, which found that habits have a minimal impact on behaviours performed only once or twice a year (Ouellette & Wood, 1998). Our findings indicate that e-waste recycling is not conducted frequently enough to establish a habit. This infrequency is likely due to the slow degradation of electronic products compared to other types of waste (Ongondo et al., 2015). Moreover, current disposal infrastructures do not facilitate the frequent collection of e-waste from consumers (Wagner et al., 2013; Islam et al., 2021). In conclusion, our results suggest that the rarity of e-waste recycling prevents the formation of corresponding habits. Therefore, in the context of e-waste, habits do not significantly influence intentions.

8.1.2. External variables

Despite the importance of internal variables like perceived behavioural control and environmental knowledge, external variables such as policy effectiveness and convenience displayed a larger effect size. Government regulations and policies are essential in motivating consumers to recycle e-waste (Wang et al., 2011; Dwivedy & Mittal, 2013). Numerous studies have shown that government rules regarding e-waste management positively impact consumers' recycling behaviours (Wang et al., 2016; Liu et al., 2019). For instance, Yu and colleagues (2010, 2014) demonstrated that government

laws and regulations play a crucial role in encouraging residents to recycle their e-waste. On the other hand, Colesca and colleagues (2014) found contrasting results; their survey revealed that Romanian residents recycle without being driven by government regulations. Our meta-analysis clarifies that the effectiveness of policies is significantly related to recycling intentions, showing a very large effect size. This finding aligns with Wan and Shen (2013), who reported that when a policy is perceived as efficient and useful, people are more motivated to comply. Consistent with previous research, our study indicates that government-implemented e-waste recycling policies positively influence users' intentions to recycle (Wan et al., 2014; Shaharudin et al., 2020).

End users' intention to recycle is heavily influenced by the convenience of recycling facilities and services (Thukral et al., 2023). Arian and colleagues (2020) recently demonstrated that having recycling sites within a reasonable distance is crucial for consumer recycling decisions. However, Ylä-Mella and colleagues (2015) presented contradictory findings. Their analysis of Finnish consumers' perceptions towards recycling revealed that the proximity and convenience of e-waste recycling sites are insufficient to encourage significant e-waste recycling. Similarly, Wang and colleagues (2016) found in their study on Chinese recycling intentions that the convenience of recycling does not significantly impact recycling behaviours, particularly in underdeveloped regions. In these areas, formal recycling centres are non-existent, and the population lacks awareness about recycling points and sites. Consequently, it is challenging for individuals to assess whether recycling collection sites are convenient for them.

Our meta-analysis sheds light on this apparent contradiction, as our results point to the idea that convenience of e-waste management services, including the number of available collection points, is a crucial situational factor that enhances perceived convenience and, in turn, fosters recycling intentions (Islam et al., 2021). This is likely because recycling e-waste is more complex and less straightforward than recycling other types of waste. It requires planning, time, and forward thinking to be carried out effectively (Wagner, 2013). As such, people factor in convenience when planning their e-waste recycling activities, influencing their intention to perform this behaviour. In essence,

recycling e-waste is a time-consuming task, and the intention to do so must be established before the behaviour can take place. It is thus curious that such an important antecedent of e-waste recycling intentions is currently neglected by the literature, as only one third of the examined studies included convenience in their analyses.

8.2. The neglected importance of situational factors

Our meta-analytic study revealed that while external factors, such as the convenience of collection centres, have a profound impact on e-waste recycling intentions and behaviours, these aspects are often overlooked in psychological research. To address this gap, the second study of this thesis focused on elucidating the influence of external variables, particularly the convenience of collection centres, on e-waste recycling behaviours. This study aimed to bridge the intention-behaviour gap by examining how such external factors affect actual recycling actions.

To achieve this, we conducted a comprehensive review of the relevant literature and developed a theoretical model grounded in goal framing theory. This model was specifically designed to explore the relationship between external factors and recycling behaviours. Our findings underscore that convenience is a critical determinant that directly influences e-waste recycling behaviours. Additionally, we discovered that both gain and normative goals serve as mediators in the relationship between convenience and recycling behaviours. This means that the perceived ease of accessing collection centres not only impacts recycling behaviours directly but also influences how individuals set goals and adhere to social norms related to recycling. Thus, our study contributes valuable insights into how external variables can shape recycling practices and highlights the importance of integrating practical factors into behavioural models.

While psychological factors undeniably play a crucial role in evaluating e-waste recycling behaviours (Dhir et al., 2021), this study emphasizes the critical need to also consider situational factors to fully understand the complexity of recycling behaviours (Canto et al., 2023). By applying goal framing theory and utilizing structural equation modelling to analyse survey data collected from 750 Italian

citizens, our study provides new insights into the interplay between situational and psychological factors in e-waste recycling.

The results revealed that gain goals, which are associated with personal benefits, had a negative impact on e-waste recycling behaviours. In contrast, normative goals, which are related to social expectations and norms, were positively associated with recycling behaviours. This finding highlights the significance of social influences in encouraging recycling practices. Unexpectedly, hedonic goals, which pertain to the pursuit of pleasure and enjoyment, did not show a significant effect on recycling behaviours.

Moreover, this study introduced a novel perspective by demonstrating that situational factors also influence goal formation. Specifically, convenience emerged as a key situational factor positively affecting e-waste recycling behaviours, as well as influencing both normative and hedonic goals. This suggests that making recycling more accessible and convenient can not only enhance recycling behaviours directly but also shape individuals' goals and motivations related to recycling. Overall, this study underscores the importance of integrating both situational and psychological factors to better understand and promote effective e-waste recycling practices.

8.3. Nudging as an innovative solution

Many environmental problems originate from human behaviour, highlighting the need for behaviour changes to maximise the benefits of technological innovations for environmental sustainability (Steg & Vlek, 2009). Strategies like information campaigns, aimed at promoting pro-environmental behaviour, often have limited success because increased environmental awareness does not necessarily result in sustainable actions (Frisk & Larson, 2011). Nudging is one approach to influencing behaviour change. Nudging leverages heuristics and biases, guiding individuals towards better choices without force. With the rise of digital technology, decisions about e-waste disposal and buying refurbished electronics increasingly occur online. While various digital nudges have been studied in contexts like food and energy, their impact on sustainable behavior, particularly in e-waste,

remains unclear. The study aimed to address this by testing social comparison feedback, an "after action" digital nudge, to encourage online purchases of refurbished products and its corresponding recycling. We hypothesized that participants would purchase second-hand electronic products more frequently in the "Nudge" condition compared to the "Control" condition (H1) and that they would choose to recycle their products more frequently in the "Nudge" condition compared to the "Control" condition (H2).

However, our results did not support these hypotheses. Participants in both groups purchased used phones and recycled their old ones at similar rates. There was no significant difference in the purchase of used phones between the nudge and control groups (H1 is rejected), nor did the nudge group recycle their old products more frequently than the control group (H2 is rejected). While the effectiveness of "before action" and "during action" digital nudges is well documented (Zimmerman et al. 2021; Berger et al., 2022), our study is the first to assess the effectiveness of "after action" digital nudges. Our findings indicate that digital nudges applied after the action (in this case, deciding which product to buy) are not effective in encouraging people to buy refurbished phones or recycle their old products.

Regression analyses suggest that other factors may have a greater influence on used phone purchases and e-waste recycling. Specifically, mean phone purchases varied by age group, with younger individuals purchasing more used phones and recycling their old phones more frequently. This contrasts with previous research indicating that older people engage in pro-environmental behaviors more often than younger generations (Wang et al., 2021). Several interpretations are possible: younger individuals may prefer used phones to save money while keeping up with the latest devices, whereas older individuals may purchase used phones less often because they do not see it as environmentally important. Additionally, studies have shown that older people are generally less knowledgeable about environmental issues than younger generations (Cheung et al., 2015).

Participants who indicated a preference for lower-priced phones demonstrated a greater likelihood of recycling their old devices. It seems that cost-conscious consumers may prioritize sustainability and

environmental considerations when making purchasing decisions, leading them to actively participate in e-waste recycling initiatives. Finally, the association between higher used phone purchases and increased likelihood of recycling old devices suggests several possible explanations. Firstly, individuals who regularly purchase used phones may be more environmentally conscious or sustainability-oriented, leading them to prioritize e-waste recycling as part of their consumption habits. Additionally, frequent buyers of used phones may perceive recycling as a responsible and ethical means of disposing of outdated or unused devices, aligning with their values and attitudes towards environmental stewardship. Moreover, this observed relationship underscores the importance of consumer behaviours, specifically purchasing habits, in driving e-waste recycling practices. This highlights the potential for targeted interventions aimed at promoting sustainable consumption behaviours, particularly among frequent purchasers of used electronics.

Participants who preferred lower-priced phones were more likely to recycle their old devices. This suggests that cost-conscious consumers may prioritize sustainability and environmental considerations in their purchasing decisions, leading to greater participation in e-waste recycling initiatives. Additionally, the link between higher used phone purchases and increased recycling likelihood can be explained in several ways. Individuals who regularly buy used phones may be more environmentally conscious, integrating e-waste recycling into their habits. These consumers might also view recycling as a responsible and ethical way to dispose of old devices, consistent with their values of environmental stewardship. This relationship highlights the significant role of consumer behaviors, particularly purchasing habits, in promoting e-waste recycling. It suggests potential for targeted interventions to encourage sustainable consumption, especially among frequent purchasers of used electronics.

9. Chapter 7: Conclusion

This thesis made a substantial theoretical contribution to the understanding of e-waste management behaviors by addressing critical gaps in the existing literature. Through a comprehensive meta-analysis, it consolidated insights from multiple behavioral theories, including the theory of planned behavior, value-belief-norm theory, and habit theories. This analysis identified key psychological drivers of e-waste recycling, such as attitudes, perceived convenience, and policy effectiveness, and provided a robust framework for understanding how these factors shape recycling intentions. The findings highlighted the importance of these constructs and their interrelationships, offering clarity on the psychological mechanisms underlying pro-environmental behaviors.

Building on this theoretical foundation, the examination of situational factors introduced a crucial dimension to understanding e-waste recycling. By analyzing the role of contextual variables, such as the proximity and accessibility of collection centers, the research demonstrated how environmental factors influence the translation of recycling intentions into concrete actions. This study underscores the necessity of integrating situational considerations into behavioral models, revealing how external conditions interact with psychological drivers to facilitate or hinder sustainable behaviors.

The third study explored the nuanced interplay between psychological drivers and decision-making processes, offering further theoretical refinement. By investigating how feedback mechanisms influence consumer decisions, the research highlighted the dynamic interaction between individual motivations and external cues. While digital interventions showed limited direct effects, the findings contributed to an enriched understanding of the complexities of behavior change in sustainability contexts.

Overall, this thesis advanced behavioral theories by integrating psychological, contextual, and motivational dimensions into a cohesive framework for understanding e-waste management. It emphasized the importance of addressing both internal and external barriers to sustainable behavior,

laying the groundwork for future research. By deepening our understanding of the multifaceted nature of e-waste recycling, this work provided a strong theoretical foundation for studying and addressing global sustainability challenges.

10. References

Aboelmaged, M. G. (2021). E-waste recycling behaviour: An integration of recycling habits into the theory of planned behaviour. *Journal of Cleaner Production, 278,* 124182. https://doi.org/10.1016/j.jclepro.2020.124182

Abrahamse, W., & Steg, L. (2009). How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *Journal of Economic Psychology, 30*, 711-720

Adidas. (2019). Infinite Play Creators Club. Retrieved from: https://www.adidas.co.uk/infiniteplay

Adkisson, R. V. (2008). Nudge: Improving decisions about health, wealth and happiness. *Social Science Journal, 45(4),* 700–701. https://doi.org/10.1016/j.soscij.2008.09.003

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50(2),* 179–211. https://doi.org/10.1016/0749-5978(91)90020-t

Alamerew, Y. A., & Brissaud, D. (2020). Modelling reverse supply chain through system dynamics for realizing the transition towards the circular economy: A case study on electric vehicle batteries. *Journal of Cleaner Production*, *254*, 120025. https://doi.org/10.1016/j.jclepro.2020.120025

Allison, A. L., Baird, H. M., Lorencatto, F., Webb, T. L., & Michie, S. (2022). Reducing plastic waste: A meta-analysis of influences on behaviour and interventions. *Journal of Cleaner Production, 380,* 134860. https://doi.org/10.1016/j.jclepro.2022.134860

Arain, A., Pummill, R., Adu-Brimpong, J., Becker, S., Green, M., Ilardi, M., Van Dam, E., & Neitzel, R. (2020). Analysis of e-waste recycling behavior based on survey at a Midwestern US University. *Waste Management*, *105*, 119–127. https://doi.org/10.1016/j.wasman.2020.02.002

Ardi, R., Iqbal, B. M., Sesarea, S., & Komarudin, K. (2020). What Drives Individuals to Dispose of Waste Mobile Phones? A Case Study in Indonesia. *International Journal of Technology: IJ Tech*. https://doi.org/10.14716/ijtech.v11i3.3855

Atasu, A. (2018). Operational perspectives on extended producer responsibility. *Journal of Industrial Ecology*, *23*(4), 744–750. https://doi.org/10.1111/jiec.12816

Bagozzi, R., Tybout, A., Craig, C., & Sternthal, B. (1979). The Construct Validity of the Tripartite Classification of Attitudes. *Journal of Marketing Research, 16*, 88 - 95. https://doi.org/10.1177/002224377901600113.

Baldé, C.P., Forti V., Gray, V., Kuehr, R., & Stegmann,,P. (2017). The Global E-waste Monitor – 2017, United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna. https://collections.unu.edu/eserv/UNU:6341/Global-E-waste_Monitor_2017__electronic_single_pages_.pdf

Bamberg, S., & Schmidt, P. (2003). Incentives, morality, or habit? Predicting students' car use for university routes with the models of Ajzen, Schwartz, and Triandis. *Environment and Behavior*, *35*(2), 264–285. https://doi.org/10.1177/0013916502250134

Bartholomew, L. K., Parcel, G. S., & Kok, G. (1998). Intervention Mapping: a process for developing Theory and Evidence-Based health education programs. *Health Education & Behavior, 25(5),* 545–563. https://doi.org/10.1177/109019819802500502

Baxter, J., Lyng, K., Askham, C., & Hanssen, O. J. (2016). High-quality collection and disposal of WEEE: Environmental impacts and resultant issues. *Waste Management, 57,* 17–26. https://doi.org/10.1016/j.wasman.2016.02.005

Bem, S. L. (1983). Gender Schema Theory and Its Implications for Child Development: Raising Gender-Aschematic Children in a Gender-Schematic Society. *Signs, 8(4),* 598–616. https://doi.org/10.1086/493998

Benartzi, S., & Lehrer, J. (2015). The smarter screen: surprising ways to influence and improve online behavior. *Choice Reviews Online, 53(10),* 53–4400. https://doi.org/10.5860/choice.196425

Benn, J. (2004). Consumer education between "consumership" and citizenship: experiences from studies of young people. *International Journal of Consumer Studies, 28(2),* 108–116. https://doi.org/10.1111/j.1470-6431.2003.00364.x

Berger, M., Müller, C., & Nüske, N (2020). Digital nudging in online grocery stores - towards ecologically sustainable nutrition. *In: Proceedings of the 41st International Conference on Information Systems.*

Berger, M., Lange, T., & Stahl, B. (2022). A digital push with real impact – Mapping effective digital nudging elements to contexts to promote environmentally sustainable behavior. *Journal of Cleaner Production, 380,* 134716. https://doi.org/10.1016/j.jclepro.2022.134716

Berman, S., & Dalzell-Payne, P. (2018). The interaction of strategy and technology in an era of business re-invention. *Strategy & Leadership*, *46*(1), 10–15. https://doi.org/10.1108/sl-10-2017-0096

Borthakur, A., & Govind, M. (2018). Public understandings of E-waste and its disposal in urban India: From a review towards a conceptual framework. *Journal of Cleaner Production*, *172*, 1053–1066. https://doi.org/10.1016/j.jclepro.2017.10.218

Borthakur, A., & Govind, M. (2019). Computer and mobile phone waste in urban India: an analysis from the perspectives of public perception, consumption and disposal behaviour. *Journal of Environmental Planning and Management*, *62*(4), 717–740. https://doi.org/10.1080/09640568.2018.1429254

Borthakur, A., & Singh, P. (2020). The journey from products to waste: a pilot study on perception and discarding of electronic waste in contemporary urban India. *Environmental Science and Pollution Research*, *28*(19), 24511–24520. https://doi.org/10.1007/s11356-020-09030-6

Botelho, A., Amorim, M., Ferreira, C., & Pinto, L. (2016). The market of electrical and electronic equipment waste in Portugal: Analysis of take-back consumers' decisions. *Waste Management & Research, 34(10),* 1074–1080. https://doi.org/10.1177/0734242x16658546

Bouvier, R., & Wagner, T. P. (2011). The influence of collection facility attributes on household collection rates of electronic waste: The case of televisions and computer monitors.

Resources, Conservation, and Recycling, 55(11), 1051–1059. https://doi.org/10.1016/j.resconrec.2011.05.019

Boyer, R. H., Hunka, A. D., Linder, M., Whalen, K. A., & Habibi, S. (2021). Product labels for the circular economy: Are customers willing to pay for circular? S*ustainable Production and Consumption, 27,* 61–71. https://doi.org/10.1016/j.spc.2020.10.010

Brigden, K., Labunska, I., Santillo, D., & Allsopp, M. (2005). *Recycling of electronic wastes in China & India: Workplace & environmental contamination*. Retrieved August 6, 2024, from https://www.greenpeace.to/greenpeace/wp-content/uploads/2011/05/electronic_waste_recycling_2005.pdf

Canto, N. R. D., Grunert, K. G., & De Barcellos, M. D. (2022). Goal-framing theory in environmental behaviours: review, future research agenda and possible applications in behavioural change. *Journal of Social Marketing, 13(1),* 20–40. https://doi.org/10.1108/jsocm-03-2021-0058

Cappa, F., Rosso, F., Giustiniano, L., & Porfiri, M. (2020). Nudging and citizen science: The effectiveness of feedback in energy-demand management. *Journal of Environmental Management, 269,* 110759. https://doi.org/10.1016/j.jenvman.2020.110759

Carlson, K., & Herdman, A. (2012). Understanding the Impact of Convergent Validity on Research Results. *Organizational Research Methods, 15,* 17 - 32. https://doi.org/10.1177/1094428110392383.

Carlsson, F., & Johansson-Stenman, O. (2012). Behavioral economics and environmental policy. *Annual Review of Resource Economics*, *4*(1), 75–99. https://doi.org/10.1146/annurev-resource-110811-114547

Casey, K., Lichrou, M., & Fitzpatrick, C. (2019). Treasured trash? A consumer perspective on small Waste Electrical and Electronic Equipment (WEEE) divestment in Ireland. *Resources Conservation and Recycling*, *145*, 179–189. https://doi.org/10.1016/j.resconrec.2019.02.015

Centro di Coordinamento RAEE (2024). *Funzionamento del sistema RAEE.* https://www.cdcraee.it/sistema-raee/funzionamento-del-sistema-

raee/#:~:text=Il%20cittadino%20o%20consumatore%20raccoglie,di%20ritiro%3A%201%20contro%201

Cerulli-Harms, A., Suter, J., Landzaat, W., Duke, C., Diaz, A.R., Porsch, L., Peroz, T., Kettner, S., Thorun, C., Svatikova, K., Vermeulen, J., Smit, T., Dekeulenaer, F., Lucica, E., 2018. Behavioural Study on Consumers' Engagement in the Circular Economy. European Commission. https://op.europa.eu/en/publication-detail/-/publication/0779f275-f9d6-11e8-a96d-01aa75ed71a1/language-en

Chakraborty, A., Singh, M., & Roy, M. (2017). A Study of Goal Frames Shaping Pro-Environmental Behaviour in University Students. *International Journal of Sustainability in Higher Education, 18,* 1291-1310. https://doi.org/10.1108/IJSHE-10-2016-0185.

Cheng, M., Hung, S., Tsai, H., & Chou, Y. (2020). Fostering environmentally responsible consumer behavior: A hierarchical approach toward smartphone recycling. *IEEE Transactions on Engineering Management, 69(5),* 2326–2336. https://doi.org/10.1109/tem.2020.3007605

Cheung, L., Fok, L., Tsang, E., Fang, W., & Tsang, H. (2015). Understanding residents' environmental knowledge in a metropolitan city of Hong Kong, China. *Environmental Education Research, 21,* 507 - 524. https://doi.org/10.1080/13504622.2014.898247.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology, 58(6),* 1015–1026. https://doi.org/10.1037/0022-3514.58.6.1015

Colesca, S., Ciocoiu, C., & Popescu, M. (2014). Determinants of WEEE Recycling Behaviour in Romania: A fuzzy Approach. *International Journal of Environmental Research*, *8*(2), 353–366. https://doi.org/10.22059/ijer.2014.726

Comrey, A. L., & Lee, H. B. (1992). Interpretation and application of factor analytic results. In: Comrey AL, Lee HB, *A first course in factor analysis, 2,* 90-112. Retrieved from: https://www.taylorfrancis.com/chapters/mono/10.4324/9781315827506-10/interpretation-application-factor-analytic-results-andrew-comrey-howard-lee?context=ubx&refId=a4923962-7d70-43b8-b9f8-590c249ea072

Crowne, D. P., & Marlowe, D. (1960). A new scale of social desirability independent of psychopathology. *Journal of Consulting Psychology, 24(4),* 349–354. https://doi.org/10.1037/h0047358

Cucchiella, F., D'Adamo, I., Koh, S. L., & Rosa, P. (2015). Recycling of WEEEs: An economic assessment of present and future e-waste streams. *Renewable and Sustainable Energy Reviews*, *51*, 263–272. https://doi.org/10.1016/j.rser.2015.06.010

Dahlke, J. A., & Wiernik, B. M. (2019). Psychmeta: An R package for psychometric meta-analysis. *Applied Psychological Measurement, 43(5),* 415–416. https://doi.org/10.1177/0146621618795933

De Groot, J. I. M., & Steg, L. (2007). General Beliefs and the Theory of Planned Behavior: The Role of Environmental Concerns in the TPB. *Journal of Applied Social Psychology, 37(8),* 1817–1836. https://doi.org/10.1111/j.1559-1816.2007.00239.x

Delcea, C., Craciun, L., Ioanăș, C., Ferruzzi, G., & Cotfas, L. (2020). Determinants of Individuals' E-Waste Recycling Decision: A Case Study from Romania. *Sustainability, 12(7),* 2753. https://doi.org/10.3390/su12072753

Dhir, A., Koshta, N., Goyal, R. K., Sakashita, M., & Almotairi, M. (2021a). Behavioral reasoning theory (BRT) perspectives on E-waste recycling and management. *Journal of Cleaner Production, 280,* 124269. https://doi.org/10.1016/j.jclepro.2020.124269

Dhir, A., Malodia, S., Awan, U., Sakashita, M., & Kaur, P. (2021b). Extended valence theory perspective on consumers' e-waste recycling intentions in Japan. *Journal of Cleaner Production, 312*, 127443. https://doi.org/10.1016/j.jclepro.2021.127443

Diddi, S., Yan, R., Bloodhart, B., Bajtelsmit, V., & McShane, K. (2019). Exploring young adult consumers' sustainable clothing consumption intention-behavior gap: A Behavioral Reasoning Theory perspective. *Sustainable Production and Consumption*, *18*, 200–209. https://doi.org/10.1016/j.spc.2019.02.009

Dixit, S., & Badgaiyan, A. J. (2016). Towards improved understanding of reverse logistics – Examining mediating role of return intention. *Resources, Conservation and Recycling, 107,* 115–128. https://doi.org/10.1016/j.resconrec.2015.11.021

Dogan, E., Steg, L., & Delhomme, P. (2011). The influence of multiple goals on driving behavior: The case of safety, time saving, and fuel saving. *Accident Analysis and Prevention, 43(5),* 1635–1643. https://doi.org/10.1016/j.aap.2011.03.002

Dowlatshahi, S. (2000). Developing a theory of reverse logistics. *Interfaces, 30(3),* 143–155. https://doi.org/10.1287/inte.30.3.143.11670

Drukker, M., Weltens, I., Van Hooijdonk, C. F. M., Vandenberk, E., & Bak, M. (2021). Development of a Methodological Quality Criteria List for Observational Studies: The Observational Study Quality Evaluation. *Frontiers in Research Metrics and Analytics, 6.* https://doi.org/10.3389/frma.2021.675071

Echegaray, F., & Hansstein, F. V. (2017). Assessing the intention-behavior gap in electronic waste recycling: the case of Brazil. *Journal of Cleaner Production, 142,* 180–190. https://doi.org/10.1016/j.jclepro.2016.05.064

Eisinga, R., Grotenhuis, M. T., & Pelzer, B. (2012). The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown? *International Journal of Public Health, 58(4),* 637–642. https://doi.org/10.1007/s00038-012-0416-3

Ellen Macarthur Foundation (2013). Towards the Circular Economy, Economic and Business Rationale for an Accelerated Transition. Available at. https://www.ellenma carthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundati on-Towards-the-Circular-Economy-vol.1.pdf. Accessed on 31 July 2020.

Ellen MacArthur Foundation (2015). Towards a Circular Economy: Business Rationale for an Accelerated Transition. Available at. https://www.ellenmacarthurfoundation. org/assets/downloads/TCE_Ellen-MacArthur-Foundation-9-Dec-2015.pdf. Accessed on 13 November 2020.

Ebeling, F., & Lotz, S. (2015). Domestic uptake of green energy promoted by opt-out tariffs. *Nature Climate Change*, *5*(9), 868–871. https://doi.org/10.1038/nclimate2681

European Commission (2024). *July Infringement Package: key decisions.* https://ec.europa.eu/commission/presscorner/detail/en/inf_24_3228

European Union (2014). Flash Eurobarometer 388 "Attitudes of Europeans Towards Waste Management and Resource Efficiency". http://ec.europa.eu/commfrontoffice/publicopinion/flash/fl_388_en.pdf.

Faiers, A., Cook, M., & Neame, C. (2007). Towards a contemporary approach for understanding consumer behaviour in the context of domestic energy use. *Energy Policy*, *35*(8), 4381–4390. https://doi.org/10.1016/j.enpol.2007.01.003

Fan, M., Khalique, A., Qalati, S. A., Gillal, F. G., & Gillal, R. G. (2022). Antecedents of sustainable e-waste disposal behavior: the moderating role of gender. *Environmental Science and Pollution Research, 29(14),* 20878–20891. https://doi.org/10.1007/s11356-021-17275-y

Fishbein, M., & Ajzen, I. (1975). *Belief, Attitude, Intention and Behavior: An Introduction to Theory and research*. https://philpapers.org/archive/FISBAI.pdf

Fishbein, M., & Ajzen, I. (2010). Predicting and changing behavior: The reasoned action approach. New York: Psychology Press.

Folkvord, F., Veltri, G., Lupiáñez-Villanueva, F., Tornese, P., Codagnone, C., & Gaskell, G. (2019). The effects of ecolabels on environmentally- and health-friendly cars: an online survey and two experimental studies. *International Journal of Life Cycle Assessment, 25(5),* 883–899. https://doi.org/10.1007/s11367-019-01644-4

Fujii, S., & Kitamura, R. (2004). What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. *Transportation, 30*, 81–95.

Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science, 2(2)*, 156–168.

Frisk, E., Larson, K.L. (2011). Educating for sustainability: competencies & practices for transformative action. *Journal of Sustainable Education, 2,* 1–20.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences, 102,* 74–78.

Goffart, J., Mara, T., & Wurtz, E. (2017). Generation of stochastic weather data for uncertainty and sensitivity analysis of a low-energy building. *Journal of Building Physics, 41(1),* 41-57. doi:10.1177/1744259116668598

Goggin, K., & Browne, J. (2000). The resource recovery level decision for end-of-life products. *Production Planning & Control, 11(7),* 628–640. https://doi.org/10.1080/095372800432098

Gu, M. (2017) Research on User Behavior of Online E-Waste Reycling Platform (April 16, 2017). Available at SSRN: https://ssrn.com/abstract=2953590 or http://dx.doi.org/10.2139/ssrn.2953590

Gupta, A., & Arora, N. (2017). Consumer adoption of m-banking: a behavioral reasoning theory perspective. *International Journal of Bank Marketing*, *35*(4), 733–747. https://doi.org/10.1108/ijbm-11-2016-0162

Habib, H., Wagner, M., Baldé, C. P., Martínez, L. H., Huisman, J., & Dewulf, J. (2022). What gets measured gets managed – does it? Uncovering the waste electrical and electronic equipment flows in the European Union. *Resources Conservation and Recycling*, *181*, 106222. https://doi.org/10.1016/j.resconrec.2022.106222

Hagberg, J., Sundström, M., & Egels-Zandén, N. (2016). The digitalization of retailing: an exploratory framework. *International Journal of Retail & Distribution Management, 44(7)*, 694–712. https://doi.org/10.1108/ijrdm-09-2015-0140

Hahnel, U. J. J., Ortmann, C., Korcaj, L., & Spada, H. (2014). What is green worth to you? Activating environmental values lowers price sensitivity towards electric vehicles. *Journal of Environmental Psychology, 40,* 306–319. doi:10.1016/j.jenvp.2014.08.0

Hansen, P. G., & Jespersen, A. M. (2013). Nudge and the Manipulation of Choice. A Framework for the Responsible Use of Nudge Approach to behaviour change in Public policy. Social Science Research Network. https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2555337_code2320150.pdf?abstractid=2555337&mirid=1&type=2

Hansla, A., Gamble, A., Juliusson, A., & Gärling, T. (2008). Psychological determinants of attitude towards and willingness to pay for green electricity. *Energy Policy, 36(2),* 768–774. https://doi.org/10.1016/j.enpol.2007.10.027

Hausman, D. M., & Welch, B. F. (2010). Debate: To nudge or not to nudge. *Journal of Political Philosophy, 18(1),* 123–136. https://doi.org/10.1111/j.1467-9760.2009.00351.x

Heir, J. F., Jr, Hult, G. T. M., Ringle, C., & Sarstedt, M. (2013). A primer on Partial Least squares Structural Equation Modeling (PLS-SEM). SAGE. ISBN: 1452217440

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and Synthesis of Research on Responsible Environmental Behavior: A Meta-Analysis. *The Journal of Environmental Education, 18(2),* 1–8. https://doi.org/10.1080/00958964.1987.9943482

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling a Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hunter, L., Hatch, A., & Johnson, A. (2004). Cross-National Gender Variation in Environmental Behaviors. *Social Science Quarterly, 85,* 677-694. https://doi.org/10.1111/J.0038-4941.2004.00239.X.

Islam, T., & Huda, N. (2019). E-waste in Australia: Generation estimation and untapped material recovery and revenue potential. *Journal of Cleaner Production, 237,* 117787. https://doi.org/10.1016/j.jclepro.2019.117787

Islam, T., Mahmud, M. a. P., Baumber, A., Shumon, M. R. H., Zaman, A., Ali, F., Hossain, R., & Sahajwalla, V. (2021). A global review of consumer behavior toward e-waste and

implications for the circular economy. *Journal of Cleaner Production, 316,* 128297. https://doi.org/10.1016/j.jclepro.2021.128297

Jabbar, A.A.D (2018). Studying the effect of institutional pressures on intention the managers of small enterprise at Thi-Qar province to adopt environmental disposal of electronic waste. Retrieved from: https://www.researchgate.net/publication/323992888_Studying_the_effect_of_institutional_pressures_on_intention_the_managers_of_Small_enterprise_at_Thi-Qar_province_to_adopt_environmental_disposal_of_electronic_waste

Kagawa, F. (2007). Dissonance in students' perceptions of sustainable development and sustainability: Implications for curriculum change. *International journal of sustainability in higher education, Online Proceedings.*

Kahneman, D. (2011). Thinking, fast and slow. http://ci.nii.ac.jp/ncid/BB2184891X

Kallbekken, S., & Sælen, H. (2013). 'Nudging' hotel guests to reduce food waste as a win–win environmental measure. *Economics Letters*, *119*(3), 325–327. https://doi.org/10.1016/j.econlet.2013.03.019

Kaur, P., Dhir, A., Singh, N., Sahu, G. P., & Almotairi, M. (2020). An innovation resistance theory perspective on mobile payment solutions. *Journal of Retailing and Consumer Services, 55,* 102059. https://doi.org/10.1016/j.jretconser.2020.102059

Keizer, K., Lindenberg, S., & Steg, L. (2013). The importance of demonstratively restoring order. *PLOS ONE, 8(6),* e65137. https://doi.org/10.1371/journal.pone.0065137

Keizer, M. (2014). Do norms matter? The role of normative considerations as predictors of proenvironmental behavior. [Thesis fully internal (DIV), University of Groningen]. Ridderprint BV.

Kianpour, K., Jusoh, A., Mardani, A., Štreimikienė, D., Cavallaro, F., Nor, K. M., & Zavadskas, E. K. (2017). Factors Influencing Consumers' Intention to Return the End-of-Life Electronic Products through Reverse Supply Chain Management for Reuse, Repair and Recycling. *Sustainability, 9(9),* 1657. https://doi.org/10.3390/su9091657

Kirakozian, A. (2016). ONE WITHOUT THE OTHER? BEHAVIOURAL AND INCENTIVE POLICIES FOR HOUSEHOLD WASTE MANAGEMENT. *Journal of Economic Surveys, 30(3),* 526–551. https://doi.org/10.1111/joes.12159

Klöckner, C. A. (2013). A comprehensive model of the psychology of environmental behaviour—A meta-analysis. *Global Environmental Change-Human and Policy Dimensions, 23(5),* 1028–1038. https://doi.org/10.1016/j.gloenvcha.2013.05.014

Knussen, C., & Yule, F. (2008). "I'm not in the habit of recycling." *Environment and Behavior*, *40*(5), 683–702. https://doi.org/10.1177/0013916507307527

Ko, E., Costello, J. P., & Taylor, C. R. (2019). What is a luxury brand? A new definition and review of the literature. *Journal of Business Research, 99,* 405–413. https://doi.org/10.1016/j.jbusres.2017.08.023

Kochan, C. G., Pourreza, S., Tran, H., & Prybutok, V. R. (2016). Determinants and logistics of e-waste recycling. *International Journal of Logistics Management/the International Journal of Logistics Management*, *27*(1), 52–70. https://doi.org/10.1108/ijlm-02-2014-0021

Kormos, C., Gifford, R., & Brown, E. (2014). The influence of descriptive social norm information on sustainable transportation behavior. *Environment and Behavior, 47(5)*, 479–501. https://doi.org/10.1177/0013916513520416

Koshta, N., Patra, S., & Singh, S. (2022). Sharing economic responsibility: Assessing end user's willingness to support E-waste reverse logistics for circular economy. *Journal of Cleaner Production, 332,* 130057. https://doi.org/10.1016/j.jclepro.2021.130057

Kroll, T., Paukstadt, U., Kreidermann, K., & Mirbabaie, M. (2019). Nudging people to save energy in smart homes with social norms and Self-Commitment. *European Conference on Information Systems.* http://dblp.uni-trier.de/db/conf/ecis/ecis2019.html#KrollPKM19

Kuhl, J., & Beckmann, J. (2012). Action Control: From Cognition to Behavior. Springer Science & Business Media.

Kumar, A., Holuszko, M. E., & Espinosa, D. C. R. (2017). E-waste: An overview on generation, collection, legislation and recycling practices. *Resources Conservation and Recycling, 122,* 32–42. https://doi.org/10.1016/j.resconrec.2017.01.018

Kumar, A. (2019). Exploring young adults' e-waste recycling behaviour using an extended theory of planned behaviour model: A cross-cultural study. *Resources, Conservation and Recycling, 141,* 378–389. https://doi.org/10.1016/j.resconrec.2018.10.013

Kurisu, K., Miura, J., Nakatani, J., & Moriguchi, Y. (2020). Hibernating behavior for household personal computers. *Resources Conservation and Recycling, 162,* 105015. https://doi.org/10.1016/j.resconrec.2020.105015

Lan, Y., & Zhu, Q (2009). Analysis and empirical research on the influencing factors of users' disposition behavior of used appliances. *Prediction, 1,* 65–70.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33(1),* 159–174. https://doi.org/10.2307/2529310

Le, H., Yamasue, E., Okumura, H., & Ishihara, K. N. (2012). Analysis of Intentions to Recycle Electronic Waste (E-Waste) Using the Theory of Planned Behavior: A Case Study in Urban Areas of Vietnam. Green Energy and Technology. https://doi.org/10.1007/978-4-431-54264-3_7

Leonard, T. C. (2008). Richard H. Thaler, Cass R. Sunstein, Nudge: Improving decisions about health, wealth, and happiness. *Constitutional Political Economy*, *19*(4), 356–360. https://doi.org/10.1007/s10602-008-9056-2

Lian, J., & Yen, D. C. (2014). Online shopping drivers and barriers for older adults: Age and gender differences. *Computers in Human Behavior, 37*, 133–143. https://doi.org/10.1016/j.chb.2014.04.028

Lindenberg, S., & Steg, L. (2007). Normative, gain and hedonic goal frames guiding environmental behavior. *Journal of Social Issues, 63(1),* 117–137. https://doi.org/10.1111/j.1540-4560.2007.00499.x

Liu, Z. (2005). Reading behavior in the digital environment. *Journal of Documentation, 61(6),* 700–712. https://doi.org/10.1108/00220410510632040

Liu, J., Bai, H., Zhang, Q., Jing, Q., & He, X. (2019). Why are obsolete mobile phones difficult to recycle in China? *Resources, Conservation and Recycling, 141,* 200–210. https://doi.org/10.1016/j.resconrec.2018.10.030

Mahmud, I., Sultana, S., Rahman, A., Ramayah, T., & Ling, T. C. (2020). E-waste recycling intention paradigm of small and medium electronics store managers in Bangladesh: An S–O–R perspective. *Waste Management & Research, 38(12),* 1438–1449. https://doi.org/10.1177/0734242x20914753

Martin, V. Y., Weiler, B., Reis, A., Dimmock, K., & Scherrer, P. (2017). 'Doing the right thing': How social science can help foster pro-environmental behaviour change in marine protected areas. *Marine Policy*, *81*, 236–246. https://doi.org/10.1016/j.marpol.2017.04.001

Martinho, G., & Magalhães, D. (2017). Consumer behavior with respect to the consumption and recycling of smartphones and tablets: An exploratory study in Portugal. *Journal of Cleaner Production, 156,* 147–158. https://doi.org/10.1016/j.jclepro.2017.04.039

McCoy, K., Oliver, J. J., Borden, D. S., & Cohn, S. I. (2018). Nudging waste diversion at Western State Colorado University: application of behavioral insights. *International Journal of Sustainability in Higher Education*, *19*(3), 608–621. https://doi.org/10.1108/ijshe-05-2017-0063

Meyer, A. (2015). Does education increase pro-environmental behavior? Evidence from Europe. *Ecological Economics, 116,* 108-121. https://doi.org/10.1016/J.ECOLECON.2015.04.018.

Michie, S., Abraham, C., Whittington, C., McAteer, J., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: A meta-regression. *Health Psychology*, *28*(6), 690–701. https://doi.org/10.1037/a0016136

Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science, 6(1).* https://doi.org/10.1186/1748-5908-6-42

Momsen, K., & Stoerk, T. (2014). From intention to action: Can nudges help consumers to choose renewable energy? *Energy Policy*, *74*, 376–382. https://doi.org/10.1016/j.enpol.2014.07.008

Mohamad, N. I., Thoo, A. C., & Huam, H. T. (2022). The Determinants of Consumers' E-Waste Recycling Behavior through the Lens of Extended Theory of Planned Behavior. *Sustainability, 14(15),* 9031. https://doi.org/10.3390/su14159031

Mouton, A.J.J (2020). A framework for the re-use, recycling and disposal of waste electrical and electronic equipment: The South African case. Retrieved from: https://repository.nwu.ac.za/handle/10394/36262

Najmi, A., Kanapathy, K., & Aziz, A. A. (2021). Understanding consumer participation in managing ICT waste: Findings from two-staged Structural Equation Modeling–Artificial Neural Network approach. *Environmental Science and Pollution Research, 28(12),* 14782–14796. https://doi.org/10.1007/s11356-020-11675-2

Nduneseokwu, C. K., Qu, Y., & Appolloni, A. (2017). Factors influencing consumers' intentions to participate in a formal E-Waste collection system: a case study of Onitsha, Nigeria. *Sustainability, 9(6),* 881. https://doi.org/10.3390/su9060881

Nguyen, H. T. T., Hung, R., Lee, C., & Nguyen, H. T. T. (2018). Determinants of Residents' E-Waste Recycling Behavioral Intention: A Case Study from Vietnam. *Sustainability, 11(1),* 164. https://doi.org/10.3390/su11010164

Nongkynrih, B., Jha, S., & Gupta, S. (2017). Electronic waste in India: Implications on health. *Indian Journal of Community and Family Medicine*, *3*(2), 8. https://doi.org/10.4103/2395-2113.251897

Nyeko, S., Mlay, S., Amerit, B. (2022). Drivers and Inhibitors of Sustainable Electronic Waste Collection and Disposal Behavioural Intentions in a Developing Country. Retrieved from: https://www.researchgate.net/publication/362105203_Drivers_and_Inhibitors_of_Sustainable_Electronic_Waste_Collection_and_Disposal_Behavioural_Intentions_in_a_Developing_Country

Nwagwu, W., & Okuneye, M. (2016). Awareness and attitudes of Small-Scale information Technology business operators in Lagos, Nigeria toward E-Waste hazards. *Journal of Global Information Technology Management*, *19*(4), 267–282. https://doi.org/10.1080/1097198x.2016.1246934

Ongondo, F., & Williams, I. H. (2011). Greening academia: Use and disposal of mobile phones among university students. *Waste Management, 31(7),* 1617–1634. https://doi.org/10.1016/j.wasman.2011.01.031

Ongondo, F., Williams, I. H., & Whitlock, G. (2015). Distinct Urban Mines: Exploiting secondary resources in unique anthropogenic spaces. *Waste Management, 45,* 4–9. https://doi.org/10.1016/j.wasman.2015.05.026

Onwezen, M. (2023). Goal-framing theory for sustainable food behaviour: The added value of a moral goal frame across different contexts. *Food Quality and Preference, 105,* 104758. https://doi.org/10.1016/j.foodqual.2022.104758

Ouellette, J.A., Wood, W., 1998. Habit and intention in everyday life: the multiple processes by which past behaviour predicts future behaviour. *Psychological Bulletin, 124,* 54–75.

Owusu-Sekyere, K., Batteiger, A., Afoblikame, R., Hafner, G., & Kranert, M. (2022). Assessing data in the informal e-waste sector: The Agbogbloshie Scrapyard. *Waste Management*, *139*, 158–167. https://doi.org/10.1016/j.wasman.2021.12.026

Papaoikonomou, K., Latinopoulos, D., Emmanouil, C., & Kungolos, A. (2020). A survey on factors influencing recycling behavior for waste of electrical and electronic equipment in the municipality of Volos, Greece. *Environmental Processes, 7(1)*, 321–339. https://doi.org/10.1007/s40710-019-00399-2

Parajuly, K., Ruediger, K., Abhishek Kumar, A., Fitzpatrick, C., Lepawsky, J., Smith, E., Widmer, R., & Zeng, X. (2019). *Future e-waste scenarios*. StEP (Bonn), UNU ViE-SCYCLE (Bonn) & UNEP IETC (Osaka). Retrieved July 10, 2024, from https://collections.unu.edu/eserv/UNU:7440/FUTURE_E-WASTE_SCENARIOS_UNU_190829_low_screen.pdf

Parajuly, K., Fitzpatrick, C., Muldoon, O. T., & Kuehr, R. (2020). Behavioral change for the circular economy: A review with focus on electronic waste management in the EU. *Resources Conservation & Recycling X, 6,* 100035. https://doi.org/10.1016/j.rcrx.2020.100035

Paterson, T. A., Harms, P. D., Steel, P., & Credé, M. (2016). An Assessment of the Magnitude of Effect Sizes. *Journal of Leadership & Organizational Studies, 23(1),* 66–81. https://doi.org/10.1177/1548051815614321

Patil, R. A., & Ramakrishna, S. (2020). A comprehensive analysis of e-waste legislation worldwide. *Environmental Science and Pollution Research International*, *27*(13), 14412–14431. https://doi.org/10.1007/s11356-020-07992-1

Perkins, D. N., Drisse, M. B., Nxele, T., & Sly, P. D. (2014). E-Waste: a global hazard. *Annals of Global Health*, *80*(4), 286. https://doi.org/10.1016/j.aogh.2014.10.001

Peng, B., Tu, Y., & Wei, G. (2018). Governance of electronic waste recycling based on social capital embeddedness theory. *Journal of Cleaner Production, 187,* 29–36. https://doi.org/10.1016/j.jclepro.2018.02.265

Peterson, M., & Simkins, T. (2019). Consumers' processing of mindful commercial car sharing. *Business Strategy and the Environment*, *28*(3), 457–465. https://doi.org/10.1002/bse.2221

Peterson, R. A., & Brown, S. S. (2005). On the Use of Beta Coefficients in Meta-Analysis. J*ournal of Applied Psychology, 90(1),* 175–181. https://doi.org/10.1037/0021-9010.90.1.175

Phulwani, P. R., Kumar, D., & Goyal, P. (2021). From systematic literature review to a conceptual framework for consumer disposal behavior towards personal communication devices. *Journal of Consumer Behaviour*, *20*(5), 1353–1370. https://doi.org/10.1002/cb.1940

Puzzo, G., & Prati, G. (2024). Psychological correlates of e-waste recycling intentions and behaviors: A meta-analysis. *Resources Conservation and Recycling, 204,* 107462. https://doi.org/10.1016/j.resconrec.2024.107462

Puzzo, G., & Prati, G. (2024). Unraveling the influence of convenience situational factors on e-waste recycling behaviors: A goal-framing theory approach. *Sustainable Development,* 1–18. https://doi.org/10.1002/sd.3164

Qalati, S. A., Vela, E. G., Li, W., Dakhan, S. A., Thuy, T. T. H., & Merani, S. H. (2021). Effects of perceived service quality, website quality, and reputation on purchase intention: The mediating and moderating roles of trust and perceived risk in online shopping. *Cogent Business & Management, 8(1).* https://doi.org/10.1080/23311975.2020.1869363

Ran, W., & Zhang, L. (2022). Bridging the intention-behavior gap in mobile phone recycling in China: the effect of consumers' price sensitivity and proactive personality. *Environment, Development and Sustainability, 25(1),* 938–959. https://doi.org/10.1007/s10668-021-02085-6

Rasheed, R., Rizwan, A., Javed, H., Sharif, F., Yasar, A., Tabinda, A. B., Mahfooz, Y., Ahmed, S., & Su, Y. (2022). Analysis of environmental sustainability of e-waste in developing countries — a case study from Pakistan. *Environmental Science and Pollution Research, 29(24)*, 36721–36739. https://doi.org/10.1007/s11356-022-18691-4

Rattazzi, A.M.M., Canova, L., & Marcorin, R. (2000). La desiderabilità sociale: un'analisi di forme brevi della scala di Marlowe e Crowne. Testing, Psychometrics, Methodology in Applied Psychology, 7(1), 5-17.

Rezvani, Z., Jansson, J., & Bengtsson, M. (2018). Consumer motivations for sustainable consumption : the interaction of gain, normative and hedonic motivations on electric vehicle adoption. *Business Strategy and The Environment, 27, 1*272-1283. https://doi.org/10.1002/BSE.2074.

Rivers, N., Shenstone-Harris, S., & Young, N. (2017). Using nudges to reduce waste? The case of Toronto's plastic bag levy. *Journal of Environmental Management*, *188*, 153–162. https://doi.org/10.1016/j.jenvman.2016.12.009

Rönkkö, M., & Cho, E. (2020). An updated guideline for Assessing Discriminant Validity. *Organizational Research Methods, 25(1),* 6–14. https://doi.org/10.1177/1094428120968614

Ryan, J., & Casidy, R. (2018). The role of brand reputation in organic food consumption: A behavioral reasoning perspective. *Journal of Retailing and Consumer Services*, *41*, 239–247. https://doi.org/10.1016/j.jretconser.2018.01.002

Sahu, A. K., Padhy, R., & Dhir, A. (2020). Envisioning the Future of Behavioral Decision-Making: A Systematic Literature Review of Behavioral Reasoning Theory. *Australasian Marketing Journal (Amj), 28(4),* 145–159. https://doi.org/10.1016/j.ausmj.2020.05.001

Saphores, J., Ogunseitan, O. A., & Shapiro, A. A. (2012). Willingness to engage in a pro-environmental behavior: An analysis of e-waste recycling based on a national survey of U.S. households. *Resources Conservation and Recycling, 60,* 49–63. https://doi.org/10.1016/j.resconrec.2011.12.003

Sarathchandra, K., & Hettiarachchib, H. (2020). Factors Affecting for E-Waste Recycling in Sri Lanka. International Journal of Scientific and Research Publications. https://doi.org/10.29322/ijsrp.10.01.2020.p9715

Schmidt, F. L., & Hunter, J. E. (2015). Methods of meta-analysis: Correcting error and bias in research findings (3rd ed.). Sage. doi: 10.4135/9781483398105

Schmidtke, K. A., Watson, D. G., Roberts, P., & Vlaev, I. (2019). Menu positions influence soft drink selection at touchscreen kiosks. *Psychology and Marketing*, *36*(10), 964–970. https://doi.org/10.1002/mar.21248

Schneider, C., Weinmann, M., & Brocke, J. V. (2018). Digital nudging. *Communications of the ACM*, *61*(7), 67–73. https://doi.org/10.1145/3213765

Schneider, D. C., Klumpe, J., Adam, M., & Benlian, A. (2019). Nudging users into digital service solutions. *Electronic Markets, 30(4)*, 863–881. https://doi.org/10.1007/s12525-019-00373-8

Schrills, T., Zoubir, M., Stahl, J., Drozniak, K., & Franke, T. (2020). Good boy here or bad boy far away? In Lecture Notes in Computer Science. https://doi.org/10.1007/978-3-030-49183-3_31

Schultz, P. W., Estrada, M., Schmitt, J., Sokoloski, R., & Silva-Send, N. (2015). Using in-home displays to provide smart meter feedback about household electricity consumption: A

randomized control trial comparing kilowatts, cost, and social norms. *Energy, 90*, 351–358. https://doi.org/10.1016/j.energy.2015.06.130

Schwartz, S.H., & Howard, J.A., 1981. A normative decision-making model of altruism. In: Rushton, J.P., Sorrentino, R.M. (Eds.), Altruism and Helping Behavior. Lawerence Erlbaum, Hillsdale, NJ, 89–211

Shaharudin, M. R., Said, R., Hotrawaisaya, C., Rashid, N. R. N. A., & Perwira, N. D. Y. (2020). Linking determinants of the youth's intentions to dispose of portable e-waste with the proper disposal behavior in Malaysia. *Social Science Journal, 1–15.* https://doi.org/10.1080/03623319.2020.1753157

Sharif, K.I.B.M., & Keat, S.B (2017). Factors influence consumer's behaviour toward logistics e-waste recycling in Malaysia. Retrieved from: https://repo.uum.edu.my/id/eprint/22638/

Sheeran, P. (2002). Intention—Behavior Relations: A Conceptual and Empirical review. *European Review of Social Psychology*, *12*(1), 1–36. https://doi.org/10.1080/14792772143000003

Shi, J., Mo, X., & Sun, Z. (2012). [Content validity index in scale development]. *PubMed*, *37*(2), 152–155. https://doi.org/10.3969/j.issn.1672-7347.2012.02.007

Shiv, B., & Fedorikhin, A. (1999). Heart and Mind in Conflict: the Interplay of Affect and Cognition in Consumer Decision Making. *Journal of Consumer Research, 26(3),* 278–292. https://doi.org/10.1086/209563

Shevchenko, T., Laitala, K., & Danko, Y. (2019). Understanding consumer E-Waste recycling behavior: Introducing a new economic incentive to increase the collection rates. *Sustainability, 11(9),* 2656. https://doi.org/10.3390/su11092656

Shobande, O. A., & Ogbeifun, L. (2021). Has information and communication technology improved environmental quality in the OECD? —a dynamic panel analysis. *International Journal of Sustainable Development & World Ecology*, *29*(1), 39–49. https://doi.org/10.1080/13504509.2021.1909172

Simamora, E. R., Farida, N., Indriani, F., & Aryanto, V. D. W. (2021). Determinants of intention of electronic waste recycling: Application of theory of planned behavior. Journal of Asian

Finance, Economics and Business, 8(3), 1095–1100. https://doi.org/10.13106/jafeb.2021.vol8.no3.1095

Singh, K., Leong, S. M., Tan, C. T., & Wong, K. C. (1995). A theory of reasoned action perspective of voting behavior: Model and empirical test. *Psychology & Marketing*, *12*(1), 37–51. https://doi.org/10.1002/mar.4220120104

Siringo, R., Herdiansyah, H., & Kusumastuti, R. D. (2020). Underlying factors behind the low participation rate in electronic waste recycling. *Global Journal of Environmental Science and Management, 6(2),* 203–214. https://doi.org/10.22034/gjesm.2020.02.06

Staikos, T., & Rahimifard, S. (2007). A decision-making model for waste management in the footwear industry. *International Journal of Production Research, 45(18–19),* 4403–4422. https://doi.org/10.1080/00207540701450187

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: Implications for the rationality debate? *Behavioral and Brain Sciences, 23(5),* 645–665. https://doi.org/10.1017/s0140525x00003435

Statista (2022a). Resource regeneration rate of cathode-ray tube (CRT) televisions in Japan from fiscal year 2013 to 2022. Statista. Retrieved January 12, 2024, from https://www.statista.com/statistics/1198533/japan-crt-television-recycling-rate/

Statista (2022b). Resource regeneration rate of washing machines and dryers in Japan from fiscal year 2013 to 2022. Statista. Retrieved January 12, 2024, from https://www.statista.com/statistics/1198522/japan-washing-machine-dryer-recycling-rate/

Statista. (2022c). Costs for flagship smartphone cameras worldwide 2019. https://www.statista.com/statistics/994007/worldwide-camera-hardware-manufacturing-costs-smartphone/)

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology, 29(3),* 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Steg, L., Bolderdijk, J. W., Keizer, K., & Perlaviciute, G. (2014). An Integrated Framework for Encouraging Pro-environmental Behaviour: The role of values, situational factors and goals. *Journal of Environmental Psychology, 38,* 104–115. https://doi.org/10.1016/j.jenvp.2014.01.002

Steg, L., Perlaviciute, G., Van Der Werff, E., & Lurvink, J. (2012). The significance of hedonic values for environmentally relevant attitudes, preferences, and actions. *Environment and Behavior, 46(2),* 163–192. https://doi.org/10.1177/0013916512454730

Steg, L., De Groot, J. I. M., Dreijerink, L., Abrahamse, W., & Siero, F. (2011). General antecedents of personal norms, policy acceptability, and intentions: The role of values, worldviews, and environmental concern. *Society and Natural Resources, 24(4),* 349-367.

Steg, L., Lindenberg, S., & Keizer, K. (2016). Intrinsic motivation, norms and environmental behaviour: the dynamics of overarching goals. *International Review of Environmental and Resource Economics, 9(1–2),* 179–207. https://doi.org/10.1561/101.00000077

Steinhilper, R. (2003). Recent trends and benefits of remanufacturing: from closed loop businesses to synergetic networks. *Proceedings Second International Symposium on Environmentally Conscious Design and Inverse Manufacturing.* https://doi.org/10.1109/ecodim.2001.992404

Steininger, K., Lininger, C., Droege, S., Roser, D., Tomlinson, L., & Meyer, L. (2014). Justice and cost effectiveness of consumption-based versus production-based approaches in the case of unilateral climate policies. *Global Environmental Change*, *24*, 75–87. https://doi.org/10.1016/j.gloenvcha.2013.10.005

Stern, P. C. (2000). New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior. J*ournal of Social Issues, 56(3),* 407–424. https://doi.org/10.1111/0022-4537.00175

Stuffstr. (2019). Everything has value: Close the loop with instant buy-back on all used garments. Retrieved from: https://www.stuffstr.com/

Sudmant, A., Gouldson, A., Millward-Hopkins, J., Scott, K., & Barrett, J. (2018). Producer cities and consumer cities: Using production- and consumption-based carbon accounts to guide

climate action in China, the UK, and the US. *Journal of Cleaner Production*, *176*, 654–662. https://doi.org/10.1016/j.jclepro.2017.12.139

Sunstein, C. R. (2014). Nudging: a very short guide. *Journal of Consumer Policy, 37(4),* 583–588. https://doi.org/10.1007/s10603-014-9273-1

Sunstein, C. R. (2015). Behavioural economics, consumption and environmental protection. In *Edward Elgar Publishing eBooks*. https://doi.org/10.4337/9781783471270.00032

Taherdoost, H. (2019). Importance of Technology Acceptance Assessment for Successful Implementation and Development of New Technologies. *Global Journal of Engineering Sciences, 1(3).* https://doi.org/10.33552/gjes.2019.01.000511

Tan, Q., Duan, H., Liu, L., Yang, J., & Li, J. (2018). Rethinking residential consumers' behavior in discarding obsolete mobile phones in China. *Journal of Cleaner Production, 195,* 1228–1236. https://doi.org/10.1016/j.jclepro.2018.05.244

Tang, Y., Chen, S., & Yuan, Z. (2020). The effects of hedonic, gain, and normative motives on sustainable consumption: multiple mediating evidence from China. Sustainable Development, 28, 741–750. doi: 10.1002/sd.2024

Tansel, B. (2017). From electronic consumer products to e-wastes: Global outlook, waste quantities, recycling challenges. *Environment International*, *98*, 35–45. https://doi.org/10.1016/j.envint.2016.10.002

Talwar, S., Dhir, A., Kaur, P., & Mäntymäki, M. (2020). Barriers toward purchasing from online travel agencies. *International Journal of Hospitality Management, 89,* 102593. https://doi.org/10.1016/j.ijhm.2020.102593

Thaler, R. H., & Sunstein, C. R. (2009). Nudge: Improving Decisions About Health, Wealth, and Happiness. Penguin.

Thukral, S., Shree, D., & Singhal, S. (2023). Consumer behaviour towards storage, disposal and recycling of e-waste: systematic review and future research prospects. *Benchmarking*, *30*(3), 1021–1072. https://doi.org/10.1108/bij-12-2021-0774

Tonglet, M., Phillips, P. S., & Read, A. D. (2004). Using the Theory of Planned Behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK. *Resources Conservation and Recycling, 41(3),* 191–214. https://doi.org/10.1016/j.resconrec.2003.11.001

Triandis, H.C., 1980. Values, attitudes, and interpersonal behavior. In: Howe, H., Page, M. (Eds.), Nebraska Symposium on Motivation 1979. University of Nebraska Press, Lincoln, 195–260.

Turaga, R. M. R., Howarth, R. B., & Borsuk, M. E. (2010). Pro-environmental behavior. *Annals of the New York Academy of Sciences*, *1185*(1), 211–224. https://doi.org/10.1111/j.1749-6632.2009.05163.x

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science, 185(4157)*, 1124–1131. https://doi.org/10.1126/science.185.4157.1124

UN (2020), "Goal 12: ensure sustainable consumption and production patterns", United Nations, available at: https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal 12-responsible-consumption-and-production.html (accessed 24 July 2024).

UNEP. (2007). E-waste Volume II: E-waste Management Manual. In *UN Environment Program*. United Nations Environment Protection. Retrieved July 10, 2024, from https://wedocs.unep.org/bitstream/handle/20.500.11822/9801/EWasteManual_Vol2.pdf?sequence=3&%3BisAllowed=

Unitar. (2020, April 8). *The Global E-waste Monitor 2020*. Retrieved July 10, 2024, from https://ewastemonitor.info/gem-2020/

Unitar. (2024, April 8). *The Global E-waste Monitor 2024 - E-Waste Monitor*. Retrieved July 10, 2024, from https://ewastemonitor.info/the-global-e-waste-monitor-2024/

Valentine, J. C., Aloe, A. M., & Wilson, S. J. (2019). Interpreting effect sizes. In H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), The handbook of research synthesis and meta-analysis (3rd ed., pp. 433–452). New York, NY: Russell Sage Foundation.

Velicer, W. F., & Fava, J. L. (2003). Time Series Analysis. In Schinka, J., & Velicer, W.F. (Eds.), Handbook of Psychology Volume 2: Research Methods in Psychology. New York: John Wiley & Sons.

Verplanken, B., & Aarts, H. H. (1999). Habit, Attitude, and Planned Behaviour: Is Habit an Empty Construct or an Interesting Case of Goal-directed Automaticity? *European Review of Social Psychology, 10(1),* 101–134. https://doi.org/10.1080/14792779943000035

Verplanken, B., & Holland, R.W. (2002). Motivated decision making: effects of activation and self-centrality of values on choices and behaviour. *Journal of Personality and Social Psychology, 82(3),* 434-447.

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software, 36(3),* 1-48. https://doi.org/10.18637/jss.v036.i03

Viechtbauer, W., & Cheung, M. W.L. (2010). Outlier and influence diagnostics for meta-analysis. *Research Synthesis Methods, 1(2),* 112–125. https://doi.org/10.1002/jrsm.11

Wagner, T. P. (2013). Examining the concept of convenient collection: An application to extended producer responsibility and product stewardship frameworks. *Waste Management, 33(3),* 499–507. https://doi.org/10.1016/j.wasman.2012.06.015

Wan, C., & Shen, G. Q. (2013). Perceived policy effectiveness and recycling behaviour: The missing link. *Waste Management, 33(4),* 783–784. https://doi.org/10.1016/j.wasman.2013.02.001

Wan, C., Shen, G. Q., & Yu, A. T. (2014). The role of perceived effectiveness of policy measures in predicting recycling behaviour in Hong Kong. *Resources Conservation and Recycling, 83,* 141–151. https://doi.org/10.1016/j.resconrec.2013.12.009

Wang, Z., Zhang, B., Yin, J., & Xiang, Z. (2011). Willingness and behavior towards e-waste recycling for residents in Beijing city, China. *Journal of Cleaner Production, 19(9–10)*, 977–984. https://doi.org/10.1016/j.jclepro.2010.09.016

Wang, Z., Guo, D., & Wang, X. (2016). Determinants of residents' e-waste recycling behaviour intentions: Evidence from China. *Journal of Cleaner Production, 137,* 850–860. https://doi.org/10.1016/j.jclepro.2016.07.155

Wang, Z., Guo, D., Wang, X., Zhang, B., & Wang, B. (2018). How does information publicity influence residents' behaviour intentions around e-waste recycling? *Resources Conservation and Recycling, 133,* 1–9. https://doi.org/10.1016/j.resconrec.2018.01.014

Wang, B., Ren, C., Dong, X., Zhang, B., & Wang, Z. (2019). Determinants shaping willingness towards on-line recycling behaviour: An empirical study of household e-waste recycling in China. *Resources, Conservation and Recycling, 143,* 218–225. https://doi.org/10.1016/j.resconrec.2019.01.005

Wang, Y., Hao, F., & Liu, Y. (2021). Pro-Environmental Behavior in an Aging World: Evidence from 31 Countries. *International Journal of Environmental Research and Public Health, 18.* https://doi.org/10.3390/ijerph18041748.

Wang, Q., Niu, G., Gan, X., & Cai, Q. (2022). Green returns to education: Does education affect pro-environmental attitudes and behaviors in China?. *PLoS ONE, 17.* https://doi.org/10.1371/journal.pone.0263383.

Wason, P. C., & St B T Evans, J. (1974). Dual processes in reasoning? *Cognition, 3(2),* 141–154. https://doi.org/10.1016/0010-0277(74)90017-1

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132(2),* 249–268. https://doi.org/10.1037/0033-2909.132.2.249

Wee, S., Choong, W., & Low, S. (2021). Can "Nudging" play a role to promote Pro-Environmental behaviour? *Environmental Challenges*, *5*, 100364. https://doi.org/10.1016/j.envc.2021.100364

Weinmann, M., Schneider, C., & Brocke, J. V. (2016). Digital nudging. *Business & Information Systems Engineering, 58(6),* 433–436. https://doi.org/10.1007/s12599-016-0453-1

Westaby, J. D. (2005). Behavioral reasoning theory: Identifying new linkages underlying intentions and behavior. *Organizational Behavior and Human Decision Processes, 98(2),* 97–120. https://doi.org/10.1016/j.obhdp.2005.07.003

Wiernik, B., Dilchert, S., & Ones, D. (2016). Age and Employee Green Behaviors: A Meta-Analysis. *Frontiers in Psychology, 7. h*ttps://doi.org/10.3389/fpsyg.2016.00194.

Wiernik, B., Kostal, J., Wilmot, M., Dilchert, S., & Ones, D. (2017). Empirical Benchmarks for Interpreting Effect Size Variability in Meta-Analysis. *Industrial and Organizational Psychology, 10(3),* 472-479. doi:10.1017/iop.2017.44

Xu, F., Wang, X., Sun, X., & Abdullah, A. T. M. (2014). Influencing factors and moderating factors of consumers' intentions to participate in e-waste recycling. *IEEE Proceedings of International Conference on Services Systems and Services Management, ICSSSM.* https://doi.org/10.1109/icsssm.2014.6874096

Xu, Y., Chen, Y., Burman, R., & Zhao, H. (2014). Second-hand clothing consumption: a cross-cultural comparison between American and Chinese young consumers. I*nternational Journal of Consumer Studies, 38,* 670-677. https://doi.org/10.1111/IJCS.12139.

Yousafzai, S. Y., Foxall, G. R., & Pallister, J. G. (2010). Explaining internet banking behavior: theory of reasoned action, theory of planned behavior, or technology acceptance model? *Journal of Applied Social Psychology*, *40*(5), 1172–1202. https://doi.org/10.1111/j.1559-1816.2010.00615.x

Zeiss, R., Ixmeier, A., Recker, J., & Kranz, J. (2020). Mobilising information systems scholarship for a circular economy: Review, synthesis, and directions for future research. *Information Systems Journal, 31(1),* 148–183. https://doi.org/10.1111/isj.12305

Zhang, L., Qu, J., Sheng, H., Yang, J., Wu, H., & Yuan, Z. (2019). Urban mining potentials of university: In-use and hibernating stocks of personal electronics and students' disposal behaviors. *Resources Conservation and Recycling, 143,* 210–217. https://doi.org/10.1016/j.resconrec.2019.01.007

Zhang, B., Du, Z., Wang, B., & Wang, Z. (2019). Motivation and challenges for e-commerce in e-waste recycling under “Big data” context: A perspective from household willingness in China. *Technological Forecasting & Social Change, 144,* 436–444. https://doi.org/10.1016/j.techfore.2018.03.001

Zhao, D., Cheah, W. Y., Lai, S. H., Ng, E., Khoo, K. S., Show, P. L., & Ling, T. C. (2023). Symbiosis of microalgae and bacteria consortium for heavy metal remediation in wastewater. *Journal of Environmental Chemical Engineering*, *11*(3), 109943. https://doi.org/10.1016/j.jece.2023.109943

Zimmermann, S., Hein, A., Schulz, T., Gewald, H., & Krcmar, H. (2021). Digital nudging toward pro-environmental behavior: A literature review. In: *Proceedings of the Twenty-Fifth Pacific Asia Conference on Information Systems.* Dubai, UAE.

Ziout, A., Azab, A., & Atwan, M. (2014). A holistic approach for decision on selection of end-of-life products recovery options. *Journal of Cleaner Production, 65,* 497–516. https://doi.org/10.1016/j.jclepro.2013.10.001

Zitzmann, S., & Hecht, M. (2019). Going Beyond Convergence in Bayesian Estimation: Why Precision Matters Too and How to Assess It. Structural Equation Modeling: A *Multidisciplinary Journal, 26(4),* 646–661. https://doi.org/10.1080/10705511.2018.1545232

11. Appendices

Appendix A. Scopus Search Code (Study 1)

((TITLE-ABS-KEY ("waste electrical and electronic equipment") OR TITLE-ABS-KEY ("e-waste") OR TITLE-ABS-KEY ("WEEE") OR TITLE-ABS-KEY ("E-waste") OR TITLE-ABS-KEY ("waste-electronics*") OR TITLE-ABS-KEY ("electronic scrap") OR TITLE-ABS-KEY ("electronics waste") OR TITLE-ABS-KEY ("obsolete electronics") OR TITLE-ABS-KEY ("waste electronics*") OR TITLE-ABS-KEY ("electronic waste*") OR TITLE-ABS-KEY ("electronic-waste*") OR TITLE-ABS-KEY ("electrical waste*") OR TITLE-ABS-KEY ("electronic waste*") OR TITLE-ABS-KEY ("waste electronic*") OR TITLE-ABS-KEY ("wastes electronic") OR TITLE-ABS-KEY ("electronic rubbish") OR TITLE-ABS-KEY ("electronic garbage") OR TITLE-ABS-KEY ("electrical rubbish") OR TITLE-ABS-KEY ("electrical garbage")) AND TITLE-ABS-KEY ("public") OR TITLE-ABS-KEY ("consumer*") OR TITLE-ABS-KEY ("customer*") OR TITLE-ABS-KEY ("resident*") OR TITLE-ABS-KEY ("household*")) AND ("survey") AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "PSYC")

Appendix B. Google Scholar Search Code (Study 1)

The following search was done on Google Scholar with the aim of including grey literature on the topic. Given the reduced flexibility of the advanced search option and the limited number of words accepted in the search bar, we had to reduce the number of keywords included. Therefore, the final search code was:

"e-waste" OR "WEEE" AND “customer*” AND “survey” AND "recycling behavior*" OR "recycling behaviour*" OR "recycling intention*”

Appendix C. Web of Science Search Code (Study 1)

((((((((((((((((((ALL=("waste electrical and electronic equipment*")) OR ALL=("ewaste")) OR ALL= ("E-waste")) OR ALL=("WEEE")) OR ALL =("waste electronics*")) OR ALL=("waste-electronics*")) OR ALL=("electronic scrap")) OR ALL=("electronics waste")) OR ALL=("obsolete electronics*")) OR ALL=("electronic-waste*")) OR ALL=("electronic waste*")) OR ALL=("electrical waste")) OR ALL=("electrical wastes")) OR ALL=("electronic wastes")) OR ALL=("waste electrical")) OR ALL=("wastes electrical") OR ALL=("waste electronic")) OR ALL=("wastes electronic")) OR ALL=("electronic rubbish")) OR ALL=("electronic garbage")) OR ALL=("electrical rubbish")) OR ALL= ("electrical garbage")) AND ALL = (public) OR ALL=(“consumer*”) OR ALL= (“customer*”) OR ALL= (“resident*”) OR ALL= (“household*”) AND ALL = (“survey”).

Appendix D. Retained Variables, theoretical definition, sample items, and theory of reference (Study 1)

Variable Name (Code)	Definition	Sample Items (Reference)	Theory and/or reference
Subjective Norms (SN)	Subjective norms are the perceived expectations of relevant other people whose behavioral alternative should be performed (in other words the social pressure) times the willingness to comply with that expectation.	"I understand the relevant laws and regulations for the recovery of e-waste"; "Most people who are important to me would approve of me recycling my household e-waste"; "The Chinese laws specify in detail the responsibility of the residents in e-waste recycling" (Wang et al., 2018). "If my family and friends recycle e-waste, I will also do it"; "Local media encourages me to participate in recycling e-waste"; "Local community influences me to participate in recycling e-waste". (Aboelmaged, 2021).	Theory of Planned Behavior (Ajzen, 1991; Klockner, 2013)
Personal Norms (PN)	Personal norms are self-expectations that are based on internalized values. Personal norms reflect commitment with internalized values and are experienced as feelings of personal obligation to engage in a certain behavior.	"I feel I should not waste anything if it could be used again"; "It would be wrong of me not to recycle my household waste"; "I would feel guilty if I did not recycle my household waste"; "Not recycling goes against my principles"; "Everybody should share the responsibility to recycle household waste"; "I am concerned with maintaining a good place to live"; "I have a strong interest in the health and well-being of the community in which I live." (Tonglet, 2004) "I feel a strong personal obligation to (recycle e-waste)"; "I am willing to put extra effort into (e-waste recycling) on a regular basis," "I would feel guilty if (I didn't recycle e-waste)" (Schwartz, 1968; Vining & Ebreo, 1992).	Norm-Activation Theory (Schwartz, 1968; 1977; Harland et al., 2006; Dixit et al., 2016; De groot & Steg, 2009)
Perceived Behavioral Control (PBC)	Perceived behavioral control is a measure that captures to which degree people have the opportunity and ability to perform a certain behavioral alternative.	"I think it's easy to send used appliances to the Internet professional recycling point"; "I don't spend a lot of time on e-waste on-line recycling points"; "There are a lot of e-waste on-line recycling points near my home"; "I clearly know the location of the e-waste online recycling point"; "Internet door-to-door recycling makes me feel very convenient"; "Internet Recycling Platform Reduces Time to Search Professional Recycling Channels" (Wang et al., 2019)	Theory of Planned Behavior (Ajzen, 1991; Klockner, 2013; Tonglet, 2004)
Perceived Convenience (PC)	Perceived convenience of e-waste recycling is defined as the time and the perceived ease of an individual in managing e-waste (Tonglet et al., 2004). Boldero (1995) argues that recycling behaviour is likely to be influenced by situational factors such as the amount of effort involved, inconvenience, storage space and access to recycling schemes.	"Near my house there are many recycling centers for electronic products"; "I found it to be easy and convenient to access the curbside pick-ups for the e-waste" (Delcea et al., 2020) "I have enough time to sort e-waste for recycling"; "I have enough time to clean up personal information on e-waste"; "I have enough space to store the e-waste for recycling" (Kochan et al., 2016)	Extended Theory of Planned Behavior (Tonglet, 2004; Boldero, 1995)
Attitudes (ATT)	Attitudes are the sum of all behavioral beliefs about a behaviour activated in a given situation. A belief is the expectation that showing a behaviour would result in a certain outcome, the likelihood that that happens and the evaluation to which degree such an outcome would be favorable. Attitudes are therefore a general measure of the favorability a	"Returning mobile-waste to producer for recycling is rewarding"; "Returning mobile-waste to producer for recycling is a responsible thing to do"; "My feelings toward returning mobile-waste to producer for recycling are favorable" (Dixit & Badgaiyan, 2016) "E-waste recycling is pleasant"; "E-waste recycling is responsible"; "E-waste recycling is good"; "E-waste recycling is beneficial"; "E-waste recycling is easy"; "E-waste recycling is	Theory of Planned Behavior (Ajzen, 1991; Klockner, 2013)

	behavioral alternative has for an individual.	sensible"; "E-waste recycling is rewarding" (Kumar, 2019)	
Environmental Knowledge (EK)	Environmental knowledge (EK) is defined as a deeper understanding of the basics of environmental issues (Athman and Monroe, 2001).	"I know that e-waste may pollute the environment or endanger human health"; "I know that there are still many substances available in e-waste"; "I think the relevant information publicity for e-waste recycling is important"; "I know the shortcomings of the informal e-waste disposal"; "I know what items of store's e-waste can be recycled"; "I know where to take my store's e-waste for recycling"; "I know how to recycle my store's e-waste" (Mahmud et al., 2020; Wang et al., 2018) "E-waste recycling is a major way to reduce landfills"; "E-waste recycling is a major way to conserve natural resources"; "E-waste recycling improves the environment" (Kochan et al., 2016)	Extended Theory of Planned Behavior (Ardi et al., 2020)
Perceived Policy Effectiveness (PPE)	Perceived policy effectiveness is defined as having a perception regarding the situational or external factor that significantly affects the relationship between waste management psychological determinants, intentions, and behaviors. This includes perceptions on how well the respective bodies or governments manage to satisfactorily work out the policies to ensure the success of such systems. (Shaharudin, 2020)	"The actions made by the government and/or NGOs for encouraging e-waste collection makes me happy"; "The services offered by the government ease the e-waste recycling process"; "NGOs are one of the main actors that encourage the e-waste recycling process"; "A program by the authorities for collecting electronic products for recycling from people's houses would be useful"; "Some specific laws on the recycling of electronic products would make me recycle more"; "I believe that if the government enforced the rules for e-waste more electronics product will be recycled" (Delcea et al., 2020).	Extended Theory of Planned Behavior (Wan et al., 2014; Shaharudin, 2020).
Perceived Benefit (PB)	Perceived benefits are defined as those perceptions that create a positive consumer perception of a particular behavior or action (Peter and Tarpey, 1975).	"Using e-waste recycling is environmentally friendly"; "Adopting e-waste recycling is better than storing the product at home"; "Using e-waste recycling is safer than reselling and storing the product" (Dhir et al., 2021b; Wang et al., 2016).	Behavioral Reasoning Theory (Westaby, 2005; Dhir et al., 2021a).
Perceived Risk (PR)	Perceived risk refers to the probability of experiencing a loss and the possible negative consequences resulting from a behavior (Ozturk et al., 2017).	"It is hard to find the e-waste collection center"; "E-waste recycling is inconvenient for me"; "E-waste recycling does not provide me with monetary benefits"; "Using e-waste recycling may lead to improper handling of the stored data" (Dhir et al., 2021b; Wang et al., 2016).	Behavioral Reasoning Theory (Westaby, 2005; Dhir et al., 2021a).
Economic Benefits (EB)	EB refers to the economic benefit of the residents who participate in electronic waste recycling (Wang et al., 2016; Cheng et al., 2020)	"Consumers who participate in e-waste collection programs by bringing their used smartphones to collection centers need to be given cash compensation (incentives)"; "Consumers who participate in e-waste collection programs by bringing their used smartphones to collection centers need to be given replacements (incentives) as discounts in purchasing new products"; "Consumers who participate in e-waste collection programs by bringing their used smartphones to collection centers need to be given replacements (incentives) as new products by adding certain costs" (Sari et al., 2021).	Wang et al., 2016
Economic Costs (EC)	EC refers to perceived costs of recycling and not the real costs allocated to recycling (Wang et al., 2016).	"I feel recyclable e-waste sell too little money."; "I feel traffic expenses of e-waste recycling are high"; "I feel handling charges of e-waste recycling are high" (Wang et al., 2016).	Wang et al., 2016

Intentions to recycle e-waste (INT)	Intentions to recycle e-waste are defined as intentions to make an effort to demonstrate the e-waste recycling behavior.	"I am interested in electronic waste recycling initiatives"; "I will give my old devices and machines to recycling firms"; "I am keen to participate in environmental programs" (Aboelmaged, 2021). "I plan on recycling more e-waste even though it will not necessarily be too easy"; "I plan on participating in the recycling activities advocated in social media"; "I intend to put more effort into everything related to the recycling of electronic products"; "In the future I intend to buy electronic products that can be recycled" (Delcea et al., 2020).	Theory of Planned Behavior (Ajzen, 1991; Klockner, 2013)
E-waste recycling behavior (BEH)	The actual behavior of recycling e-waste. The behavior of interest must be clearly defined in terms of its target, action, context, and time elements.	"I have returned e-waste to companies for recycling" (Dixit & Badgayian, 2016) "Dispose of them [e-waste] properly"; "Drop them off to the nearby collection center"; "Return them to the retailer"; "Return them to the manufacturer"; "Follow the disposal advise by the authorities" (Shaharudin et al., 2020)	Theory of Planned Behavior (Ajzen, 1991; Klockner, 2013)
Habits (HAB)	Habits are the automatic performance of behavioral patterns triggered by context cues (Triandis, 1980). Habits reflect a learned automatic response that maintains repetitive actions in certain situations (Wood et al., 2014)	"Recycling electronic waste has become a habit for me"; "Recycling electronic waste has become a common behaviour to me"; "I must participate in recycling electronic waste as a habit" (Aboelmaged, 2021) "I do not often employ e-commerce for shopping" (Zhang et al., 2019).	Extended Theory of Planned Behavior (Triandis, 1980; Wood et al., 2014; Klockner, 2013).

Appendix E. Questionnaire (Study 2)

***** english version below*****

COMPORTAMENTO STAZIONE ECOLOGICA. Seppure sia un'azione poco frequente, la prego di indicarmi su una scala da 1 (= Mai) a 5 (= Molto spesso), quanto spesso ha portato alla stazione ecologica le apparecchiature delle seguenti categorie RAEE nel momento in cui non le ha più utilizzate. *(risposta multipla)*

		Da leggere solo se richiesto	**1 = mai**	**2 = raramente**	**3 = qualche volta**	**4 = spesso**	**5 = Molto spesso**
R1	Freddo e clima	*Frigoriferi, condizionatori, congelatori, ecc.*					
R2	Grandi Bianchi	*Lavatrici, asciugatrici, lavastoviglie, cappe, forni, ecc.*					
R3	Tv e Monitor	*Televisori e schermi a tubo catodico, lcd o plasma, ecc.*					
R4	Piccoli Elettrodomestici	*Phon, microonde, apparecchi di illuminazione, pannelli fotovoltaici, ecc.*					
	Pc e apparecchi informatici, telefonini						
R5	Sorgenti Luminose	*Lampadine a basso consumo, lampade e led, lampade a neon, lampade fluorescenti, ecc.*					

GOALS. Per le seguenti affermazioni, indichi il suo grado di accordo su una scala da 1 (= per nulla d'accordo) a 5 (= completamente d'accordo). (3 = né in accordo né in disaccordo). *(risposta multipla)*

Non leggere		**1**	**2**	**3**	**4**	**5**
Gain Goals	1. Portare i RAEE alla stazione ecologica è una perdita di tempo					
	2. Portare i RAEE alla stazione ecologica è stancante					
	3. Portare i RAEE alla stazione ecologica non porta benefici economici					
Hed. Goals	1. Portare un RAEE alla stazione ecologica, rende orgogliosi di se stessi					
	2. Portare i RAEE alla stazione ecologica dà soddisfazione					
Norm. Goals	4. Non portare i RAEE alla stazione ecologica può far sentire in colpa					
	5. Portare i RAEE alla stazione ecologica è motivato da un senso di responsabilità					

	6. Portare i RAEE alla stazione ecologica è la cosa giusta da fare					

PERCEIVED CONVENIENCE. Indichi per ogni affermazione il suo grado di accordo su una scala da 1 (= per nulla d'accordo) a 5 (= completamente d'accordo). (3 = né in accordo né in disaccordo). *(risposta multipla)*

Non leggere		1	2	3	4	5
Proximity	1. Le stazioni ecologiche sono vicine a dove vive					
	2. Ha bisogno di molto tempo per recarsi alla stazione ecologica					
Availability	3. I giorni di apertura delle stazioni ecologiche le permettono di andarci facilmente					
	4. Gli orari di apertura delle stazioni ecologiche sono comodi					
	5. È facile trovare la stazione ecologica dove recarsi					
Ease of the service (User Experience)	6. È stato facile accedere alla stazione ecologica					
	7. Il servizio offerto dalle stazioni ecologiche è veloce					
	8. Il servizio offerto dalle stazioni ecologiche è efficiente					
	9. E' semplice orientarsi all'interno della stazione ecologica					

VALORI. Indichi su una scala da 0 (= non importante) a 7 (= estremamente importante) il grado con cui valuta i seguenti valori come "principi guida della sua vita". *(risposta multipla)*

Non leggere		**0= non importante**	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7= estremamente importante**
Hedonic Values	1. Piacere (massimizzare il proprio piacere nel fare le cose)								
	2. Godersi la vita (ridurre al minimo le preoccupazioni)								
	3. Gratificazione personale (sentirsi soddisfatti e/o orgogliosi di ciò che si fa)								
Egoistic Values	4. Potere sociale (controllo sugli altri, dominanza)								
	5. Benessere materiale (possessioni materiali, soldi) 6. Autorità (avere la possibilità di comandare)								
	7. Influenza (avere un impatto sulle altre persone e sul corso degli eventi)								
	8. Ambizione (lavorare sodo, aspirare a ottenere meglio per sé)								
Altruistic Values	9. Uguaglianza (opportunità uguali per tutte le persone)								

	10. La pace nel mondo (desiderare un mondo libero da guerre e conflitti)								
	11. Giustizia sociale (affrontare le ingiustizie, avere cura delle persone più deboli)								
	12. Essere di aiuto (lavorare per migliorare il benessere altrui)								
Biospheric Values	13. Rispetto della terra (raggiungere un'armonia con le altre specie)								
	14. Unione con la natura (adattarsi alle esigenze della natura)								
	15. Protezione dell'ambiente (preservare la natura)								
	16. Prevenzione dell'inquinamento (proteggere le risorse naturali)								

GENERE. Qual è la sua identità di genere? *(risposta singola)*
1. Uomo
2. Donna
3. Altro: _____
4. Preferisce non rispondere

ETA'. Quanti anni ha? *(risposta singola)*

_____

LAVORO. Attualmente lavora o studia? *(risposta singola)*
1. Studia a tempo pieno
2. Lavora a tempo pieno
3. Lavora part-time (incluso per gli studi)
4. Lavora come casalingo/a
5. È disoccupato/a
6. È pensionato/a

STUDI. Qual è il titolo di studio piu' elevato che ha conseguito? *(risposta singola)*
1. Scuola elementare
2. Scuola media
3. Scuola superiore
4. Laurea triennale
5. Laurea magistrale
6. Master post-laurea
7. Dottorato
8. Altro: _____

REDDITO. Negli ultimi 12 mesi le risorse economiche complessive del suo nucleo familiare sono state…
(risposta singola)

1. Ottime	1. Adeguate	2. Scarse	4. Insufficienti

E-WASTE RECYCLING BEHAVIORS. While this is an infrequent action, please indicate on a scale of 1 (= Never) to 5 (= Very often), how often did you take equipment in the following WEEE categories to the collection center when you no longer used them. (multiple answer)

		Examples	**1 = never**	**2 = rarely**	**3 = sometimes**	**4 = often**	**5 = very often**
R1	Climate	*Fridges, air conditioners, refrigerators, etc.*					
R2	"Big Whites"	*Dishwashers, washers, ovens, etc.*					
R3	TVs and Monitors	*Televisions and monitors, etc.*					
R4	Small household appliances	*Air dryers, microwaves, etc.*					
	Computers and informatics	*Laptops, electronic equipment, smartphones, etc.*					
R5	Light sources	*Light bulbs, led bulbs, neon bulbs, etc.*					

GOALS. For the following statements, indicate your degree of agreement on a scale of 1 (= not at all agree) to 5 (= completely agree). (3 = neither agree nor disagree). (multiple response)

		1	**2**	**3**	**4**	**5**
Gain Goals	Taking WEEE to the collection center is a waste of time					
	Taking WEEE to the collection center is tiring					
	Taking WEEE to the collection center does not bring economic benefits					
Hed. Goals	Taking WEEE to the collection center makes one proud of oneself					
	Taking WEEE to the collection center is a satisfying activity					
Norm. Goals	Not taking WEEE to the collection center makes one feel guilty					
	Taking WEEE to the collection center gives one a sense of responsibility					
	Taking WEEE to the collection center is the right thing to do					

PERCEIVED CONVENIENCE. For the following statements, indicate your degree of agreement on a scale of 1 (= not at all agree) to 5 (= completely agree). (3 = neither agree nor disagree). (multiple response) *(multiple response)*

		1	2	3	4	5
Proximity	Collection centers are close by to where you live					
	You need a lot of time to reach a collection center					
Availability	Opening days of collection centers allow you to flexibly reach it					
	Opening hours of collection centers allow you to flexibly reach it					
	It's easy to get to a collection center close by					
Ease of the service (User Experience)	It's easy to access a collection center					
	The service offered by the collection center is fast					
	The service offered by the collection center is efficient					
	It's easy to navigate a recycling area					

VALORI. For the following values, indicate your degree of importance on a scale of 0 (= not at all important) to 7 (= extremely important) as "guiding life principles" of your life. *(multiple response)*

		0	1.	2.	3.	4.	5.	6.	7
Hedonic Values	Pleasure								
	Enjoying life								
	Gratification for oneself								
Egoistic Values	Social power								
	Wealth								
	Authority								
	Being influential								
	Being ambitious								
Biospheric Values	Respecting the earth								
	Being one with nature								
	Protecting the environment								
	Preventing pollution								

GENDER. What is your gender identity?

1. Man
2. Woman
3. Other: _____
4. Prefers not to answer

AGE. How old are you? (single answer)

_____

WORK. Are you currently working or studying? (single answer)

1. Student
2. Employed full-time
3. Employed part-time (including for studies)
4. Homemaker
5. Unemployed
6. Retired

STUDIES. What is the highest degree or level of school you have completed? (single answer)

1. Elementary school or lower
2. Middle school
3. High school
4. Bachelor's degree
5. Master's degree
6. Postgraduate master's degree
7. Doctorate
8. Other: _____

INCOME. In the past 12 months, the total economic resources of your household were...

(single answer)

1.Excellent 2. Adequate 3. Poor 4. Insufficient

Appendix F. Results of meta-analysis

Independent Variable	Dependent Variable	*k*	*N*	$\underline{r}$	SD_r	SD_{res}	$\underline{\rho}$	SD_{r_c}	SD_ρ	95% CI	80% CR	*Q*	I^2
Intentions	Behaviors	6	2 881	.33	.12	.11	.42	.13	.12	[0.29, 0.56]	[0.25, 0.60]	30.71***	83.7%
Attitudes	Intentions	25	13 417	.35	.13	.13	.42	.17	.17	[0.35, 0.50]	[0.20, 0.64]	330.87***	92.8%
Subjective Norms	Intentions	25	13 208	.29	.16	.16	.35	.20	.20	[0.26, 0.43]	[0.08, 0.61]	422.94***	94.3%
PBC	Intentions	21	10 831	.28	.15	.14	.35	.18	.18	[0.27, 0.43]	[0.11, 0.58]	267.48***	92.5%
Knowledge	Intentions	14	6 367	.28	.15	.14	.33	.19	.18	[0.22, 0.44]	[0.08, 0.57]	167.89***	92.3%
Convenience	Intentions	12	3 895	.38	.19	.18	.49	.25	.24	[0.33, 0.64]	[0.15, 0.82]	180.87***	93.9%
Policy Effectiveness	Intentions	6	2 078	.41	.25	.25	.48	.31	.30	[0.16, 0.80]	[0.03, 0.93]	169.92***	97.1%
Economic Benefits	Intentions	7	5 253	.27	.11	.10	.34	.15	.15	[0.19, 0.48]	[0.12, 0.55]	75.53***	92.1%
Economic Costs	Intentions	4	2 462	−.18	.25	.24	−.22	.34	.34	[−0.76, 0.33]	[−0.77, 0.34]	25.93***	84.6%
Personal Norms	Intentions	7	2 601	.29	.21	.20	.36	.26	.25	[0.12, 0.60]	[−0.01, 0.72]	117.94***	94.9%
Habits	Intentions	3	3 080	.18	.28	.28	.25	.34	.33	[−0.59, 1.08]	[−0.38, 0.88]	152.01***	98.7%
Perceived Benefits	Intentions	7	3 040	.41	.08	.06	.53	.10	.08	[0.44, 0.62]	[0.41, 0.65]	22.26**	73.0%
Perceived Risks	Intentions	5	2 617	.20	.57	.57	.25	.71	.70	[−0.63, 1.13]	[−0.83, 1.33]	734.08***	99.5%

Note: PBC = perceived behavioral control; *k* = number of studies contributing to meta-analysis; *N* = total sample size; $\underline{r}$ = mean observed correlation; SD_r = observed standard deviation of *r*; SD_{res} = residual standard deviation of *r*; $\underline{\rho}$ = mean true-score correlation; SD_{r_c} = observed standard deviation of corrected correlations (r_c); SD_ρ = residual standard deviation of ρ; CI = confidence interval around $\underline{\rho}$; CR = credibility interval around $\underline{\rho}$; *Q* = Q statistic; I^2 = I^2 statistic. Correlations corrected individually.
* p < .05; ** p < .01; *** p < .001

REPORT OF SCIENTIFIC ACTIVITY

Gabriele Puzzo, tutor: prof. Gabriele Prati

Teaching Activities Followed in the PhD Program in Psychology (Courses)

****Fill the table with information about the courses offered by the PhD program in Psychology you have followed*

Teacher	Course Title	N hours	Exam (Yes/No)	If yes, exam passed (yes/no)
-*Various*-	Journal Club	14	No	
Benassi, Giovagnoli, Garofalo	What is Validity? Statistical and Methodological Issues	8	Yes	Yes
Valsecchi	From Validity to Reproducibility	9	Yes	Yes
Balducci	Multilevel Modelling	8	No	
Costa	R Coding in Psychological Research	8	No	
Pietrantoni, De Angelis	Big data in psychological research: applications and challenges	8	Yes	Yes
De Cesarei	Organizing and Writing a Research Report	8	Yes	Yes
Marco De Angelis	Innovative dissemination of research results: Data visualization examples and tools	4	Yes	Yes
Michela Menegatti	Gender balance in research practices	4	Yes	Yes
Raffaella Nori	The Publication Process: Selecting journals and preparing submissions	4	Yes	Yes

TOTAL HOURS OF:

- COURSES WITH EXAM: 45
- COURSES WITHOUT EXAM: 30

Conference Presentations

Fraboni, F., Puzzo, G., Pesenti, M., Roveda, L., Pietrantoni, L. (2022). Benchmarking Usability and Acceptance of Lower-Back Support Occupational Exoskeletons: The XSPINE project. 17th European Congress of Psychology, Lubjiana (SI), 7th – 9th July 2022.

Fraboni, F., Gualtieri, L., Puzzo, G., Brendel, H., Pietrantoni, L., Rauch, E. (2023). Development of a Toolkit for Improving Workers' Well-being in Collaborative Robotics - An Experts' Survey. *Oral presentation at 21st EAWOP congress, Katowice (PL),* 24th – 27th May, 2023

Morandini, S., Fraboni, F., Puzzo, G., Giusino, D., Volpi, L., Brendel, H., Balatti, E., De Angelis, M., De Cesarei, A., & Pietrantoni, L. (2023). Examining the Nexus Between Explainability of AI Systems and User's trust: A preliminary Scoping Review. *xAI 2023: 1st World Conference On eXplainable Artificial Intelligence, Lisbon (PT)*, 26th – 28th July 2023. Poster Presentation.

Puzzo, G., Sbaa, M.Y., Pietrantoni, L., & Zappalà, S. (2022). Implications of COVID-19 Pandemic on organizational effectiveness and job satisfaction of frontline practitioners working with migrant people". 20th EAWOP Congress, Glasgow (UK), 11th -14th January 2022. Canceled event.

Puzzo, G., Sbaa, M.Y., Zappalà, S., & Pietrantoni, L. (2022). Met job expectations and perceived professional role identity in Gambian Journalists. 20th EAWOP Congress, Glasgow (UK), 11th -14th January 2022. Canceled event.

Puzzo, G., Fraboni, F., Pietrantoni, L. (2022). COVID-19 pandemic impact, organizational effectiveness, and job satisfaction of practitioners working with migrants. 17th European Congress of Psychology, Lubjiana (SI), 7th – 9th July 2022.

Puzzo, G., Prati, G., Fraboni, F., Pietrantoni, L. (2022). A systematic literature review on behavioral interventions to improve e-waste management. 17th European Congress of Psychology, Lubjiana (SI), 7th – 9th July 2022.

Puzzo, G., Prati, G. Promoting e-waste recycling in a multi-service company: a human-factor methodology. XXX Congresso Nazionale AIP, Padova (IT), 19th-23th September 2022.

Sbaa, M.Y., Puzzo, G., Zappalà, S., & Pietrantoni, L. (2022). Job satisfaction of migration frontline practitioners in COVID times: a comparative study in three countries. 20th EAWOP Congress, Glasgow (UK), 11th -14th January 2022. Canceled Event.

Sbaa, M.Y., Puzzo, G., Pietrantoni, L., & Zappalà, S. (2021). The impact of cultural intelligence on burnout among practitioners working with migrants: an examination of age, gender, training, and language proficiency. XXX Congresso Nazionale AIP, Padova (IT), 19th-23th September 2022.

Poster Presentations

Brendel, H., Fraboni, F., Gualtieri, L., Puzzo, G., & Pietrantoni, L. (2023). Improving and Extending Design Guidelines for Human-Robot Collaboration in the Workplace. Human Factors & Ergonomics Society Congress, Liverpool (UK), 24th – 27th April 2023.

Fraboni, F., Gualtieri, L., Puzzo, G., Brendel, H., Pietrantoni, L., Rauch, E. (2023). Development of a Toolkit for Improving Workers' Well-being in Collaborative Robotics - An Experts' Survey. Oral presentation at 21st EAWOP congress, Katowice (PL), 24th – 27th May, 2023.

Morandini, S., Fraboni, F., Puzzo, G., Giusino, D., Volpi, L., Brendel, H., Balatti, E., De Angelis, M., De Cesarei, A., & Pietrantoni, L. (2023). Examining the Nexus Between Explainability of AI Systems and User's trust: A preliminary Scoping Review. xAI 2023: 1st World Conference On eXplainable Artificial Intelligence, Lisbon (PT), 26th – 28th July 2023.

Puzzo, G., Fraboni, F., Pesenti, M., Roveda, L., Pietrantoni, L. (2022). Usability and Acceptance of Lower-Back Support Occupational Exoskeletons: The XSPINE project. Human Factors and Ergonomic Society Europe Chapter, Turin (IT), 6th – 8th April 2022.

Puzzo, G., Fraboni, F., Panchetti, T., & Pietrantoni, L. (2022). User-based ergonomic design of passive exoskeletons: the STEP-BY-STEP Project. Human Factors & Ergonomics Society Congress, Turin (IT), 6 th – 8 th April 2022.

Panchetti, T., Fraboni, F., Puzzo, G., & Pietrantoni, L. (2022). Assessing the Relationship between Cognitive Workload, Workstation Design, User Acceptance and Trust in Collaborative Robots. Human Factors & Ergonomics Society Congress, Turin (IT), 6 th – 8 th April 2022.

Sbaa, M.Y., Puzzo, G., Zappalà, S., & Pietrantoni, L. (2022). Job satisfaction of migration frontline practitioners in COVID times: a comparative study in three countries.) 15th European Academy of Occupational Health Psychology Conference, Bordeaux (FR), 6 th – 8 th July 2022.

Zappalà, S., Sbaa, M.Y., Puzzo, G., Pietrantoni, L. (2022). Impact of COVID-19 pandemic on perceptions of organizational effectiveness and job satisfaction of frontline practitioners working with migrant people. 15th European Academy of Occupational Health Psychology Conference, Bordeaux (FR), 6th – 8th July 2022.

Zappalà, S., Sbaa, M.Y., Puzzo, G., Pietrantoni, L. (2022). Job Burnout and Intercultural skills of Frontline Practitioners working with migrants. 15th European Academy of Occupational Health Psychology Conference, Bordeaux (FR), 6th – 8th July 2022.

Publications

Brendel, H., Sbaa, M. Y., Zappala, S., Puzzo, G., & Pietrantoni, L. (2023). The Impact of Work-Related Barriers on Job Satisfaction of Practitioners Working with Migrants. *Social Sciences*, *12*(2), 98. https://doi.org/10.3390/socsci12020098

Morandini, S., Fraboni, F., Balatti, E., Hackmann, A., Brendel, H., Puzzo, G., Volpi, L., Giusino, D., De Angelis, M., & Pietrantoni, L. (2023). Assessing the Transparency and Explainability of AI Algorithms in Planning and Scheduling tools: A Review of the Literature. *10th International Conference on Human Interaction and Emerging Technologies (IHIET 2023).* https://doi.org/10.54941/ahfe1004068

Morandini, S., Fraboni, F., De Angelis, M., Puzzo, G., Giusino, D., & Pietrantoni, L. (2023). The Impact of Artificial Intelligence on Workers' Skills: Upskilling and Reskilling in Organisations. *Informing Science the International Journal of an Emerging Transdiscipline*, *26*, 039–068. https://doi.org/10.28945/5078

Panchetti, T., Pietrantoni, L., Puzzo, G., Gualtieri, L., & Fraboni, F. (2023). Assessing the Relationship between Cognitive Workload, Workstation Design, User Acceptance and Trust

in Collaborative Robots. *Applied Sciences*, *13*(3), 1720. https://doi.org/10.3390/app13031720

Petruzziello, G., Soncini, A., Toscano, F., Puzzo, G., De Sio, S., Giusino, D., & Tomei, G. (2024). 'Is it me or...?'. A multimethod study to explore the impact of personal and contextual factors on PhD students' well-being. European Journal of Higher Education, 1–27. https://doi.org/10.1080/21568235.2024.2352445

Petruzziello, G., Soncini, A., Toscano, F., Puzzo, G., & Tomei, G. (2024). The Psychological and Professional Well-Being of Doctoral Students: Insights from Two Cohorts of a Major Italian University. In book: Advances in Psychology Research. Volume 153 Chapter: 1Publisher: Nova Publishers.

Puzzo, G., Sbaa, M. Y., Zappala, S., & Pietrantoni, L. (2023). Job Expectations and Professional Role Identity in Gambian Journalists: The Mediation Role of Job Satisfaction. *Societies*, *13*(3), 71. https://doi.org/10.3390/soc13030071

Puzzo, G., Sbaa, M. Y., Zappalà, S., & Pietrantoni, L. (2023). The impact of cultural intelligence on burnout among practitioners working with migrants: an examination of age, gender, training, and language proficiency. *Current Psychology*. https://doi.org/10.1007/s12144-023-04641-x

Puzzo, G., & Prati, G. (2024). Psychological correlates of e-waste recycling intentions and behaviors: A meta-analysis. *Resources, Conservation and Recycling, 204,* 107462. https://doi.org/10.1016/j.resconrec.2024.107462

Puzzo, G., & Prati, G. (2024). Unraveling the influence of convenience situational factors on e-waste recycling behaviors: A goal-framing theory approach. *Sustainable Development,* 1–18. https://doi.org/10.1002/sd.3164

Established collaborations

Hera SpA – Multiservice Company. Established collaboration to conduct research together during the entire 3-year PhD project span

Dismeco Srl - E-waste disposal Company. Established collaboration to enter a consortium (Leader: Dismeco Srl) and written project application for LIFE Call “Circular Economy and Quality of Life - Standard Action Projects SAP” (LIFE-2024-SAP-ENV).

Other Activities

Design, organization and implementation of needs analysis in Hera SpA.

Design, organization and implementation of Hierarchical Task Analysis in Hera SpA.

Design, organization and implementation of Human Reliability Assessment in Hera SpA.

Presentation of Hierarchical Task Analysis and Human Reliability Assessment to Hera SpA Managerial council.

Writing and submitting Proposal for LIFE Call “Circular Economy and Quality of Life - Standard Action Projects SAP” (LIFE-2024-SAP-ENV), leader DISMECO Srl.

Active collaboration with research group “HFRS” on Human Factors, Risk, and Safety (leader prof. Luca Pietrantoni). Presented research results at conferences, published articles and book chapters, written Horizon Europe Project proposals, active participation in H2020 EU project PERCEPTIONS (written deliverables, participated in the organization of the final event, active attendance to final review meeting).

Active collaboration with research group PhWE on PhD students’ wellbeing. Presented research results at symposiums, published articles and book chapters.

Call Application Post-Laurea - “Ripartire da qui - Vivere bene la fragilità nei diversi contesti di vita. La Psicologia in campo tra ricerca, clinica e territorio” (issued by Ser.In.Ar. Forlì-Cesena Soc. Cons. p. A). Written video script, participated in video direction and montage, attended corresponding events.