RECYCLING BEHAVIOURS AMONG HIGHER EDUCATION STUDENTS IN PORTUGAL: INSIGHTS FROM A CROSS-SECTIONAL QUANTITATIVE ANALYSIS OF BEHAVIOURAL DETERMINANTS

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Abstract

Recycling plays a crucial role in addressing the consequences of global warming and the ongoing climate crisis. However, research on the determinants of recycling behaviours in Portugal is limited. This cross-sectional study focused on recycling behaviours among university students in Portugal, employing an online self-report questionnaire with a sample size of N=195 participants, ranging in age from 17 to 70. The majority of participants (69.7%) were female, and there was a notable concentration in the Lisbon region. Our investigation aimed to comprehensively explore recycling behaviours, specifically examining the frequency of separation and disposal behaviours and their determinants based on the Capability, Opportunity, Motivation – Behaviour (COM-B) model. Assessment of separation and disposal behaviours across various recyclable waste categories revealed that glass, paper, and plastic were the most frequently recycled items, with moderate overall engagement, highlighting the need for targeted policy interventions. The study explored associations between separation and disposal behaviour frequencies and their respective COM-B determinants. For separation, the behavioural determinants most strongly associated with the frequency of recycling behaviours were physical opportunity, social opportunity, and automatic motivation. As for disposal the determinants most strongly associated with the frequency of disposal behaviours were psychological capability, physical opportunity, social opportunity, and automatic motivation. Additionally, the study aimed to identify key predictors from the COM-B model for both separation and disposal behaviours. The main findings are that automatic motivation was strongly associated and significantly predicted both separation and disposal behaviours. Results suggests that interventions targeting automatic motivation for both separation and disposal behaviours, hold promise. The study provides valuable insights for future research and intervention design.

Key words: Recycling, Portugal, COM-B Model, Behavior Change.

Resumo

A reciclagem desempenha um papel crucial na resposta às consequências do aquecimento global e da decorrente crise climática. No entanto, a investigação sobre determinantes comportamentais de reciclagem em Portugal é limitada. Este estudo transversal centrou-se nos comportamentos de reciclagem de estudantes universitários em Portugal, utilizando um questionário de autorrelato online com uma amostra de N=195 participantes, com idades compreendidas entre os 17 e os 70 anos. A maioria dos participantes (69,7%) identificou-se com o género feminino, verificando-se uma notável concentração na região de Lisboa. A

presente investigação teve como objetivo explorar os comportamentos de reciclagem, examinando a frequência dos comportamentos de separação e descarte e seus determinantes com base no modelo Capability, Opportunity, Motivation – Behaviour (COM-B). A avaliação dos comportamentos de separação e descarte de várias categorias de resíduos recicláveis revelou que o vidro, o papel e o plástico foram os artigos reciclados com mais frequência. O nível de participação geral na reciclagem revelou-se moderado, destacando a necessidade de intervenções políticas específicas. O estudo explorou associações entre frequências de comportamento de separação e descarte e seus respetivos determinantes COM-B. Para a separação, os determinantes comportamentais mais fortemente associados à frequência de comportamentos de reciclagem foram oportunidade física, oportunidade social e motivação automática. Quanto ao descarte, os determinantes mais fortemente associados à frequência de comportamentos de descarte foram capacidade psicológica, oportunidade física, oportunidade social e motivação automática. Além disso, o estudo teve como objetivo identificar os principais preditores do modelo COM-B para comportamentos de separação e descarte. A conclusão central é que a motivação automática mostrou uma forte associação demonstrou ser um preditor significativo de ambos os comportamentos de separação e descarte. Os resultados sugerem que as intervenções que visam a motivação automática tanto para os comportamentos de separação como de eliminação são promissoras. O estudo fornece informações valiosas para futuras pesquisas e projetos de intervenção.

Palavras-chave: Reciclagem, Portugal, Modelo COM-B, Mudança comportamental.

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Introduction

Human activities have caused unprecedented global warming (Steffen et al., 2015; IPCC, 2021), profoundly impacting Earth's climate and ecosystems. This human-induced environmental change, referred to as the Anthropocene era, is characterized by the rising of greenhouse gas emissions, ocean acidification, loss of tropical forests, and more (Steffen et al., 2015). These changes lead to "climate change," with far-reaching consequences for the environment and human life (Millennium Ecosystem Assessment, 2005; Steffen, Richardson, et al., 2015).

Recent research shows that Earth has already exceeded safe planetary boundaries in areas like climate change and biodiversity loss (Steffen, Richardson, et al., 2015). This overexploitation of ecosystems pushes the planet beyond its capacity to support life (Rockström et al., 2009).

The climate emergency results in extreme weather events, biodiversity loss, sea-level rise, and food security concerns. Addressing this global crisis demands collective international action, changes in government policies, sustainable business choices, and individual actions (Ripple et al., 2021). The ongoing climate emergency has far-reaching consequences, not only for the environment but also for human health. The concept of “planetary health” refers to the dependence of human health on Earth’s systems that sustain life. (McLean et al., 2022) Environmental changes can impact human health through factors, such as air and water pollution, changes in climate and food security. (IPCC, 2014; Manisalidis et al., 2020) It affects health directly and indirectly, causing various diseases and mental health issues (World Health Organization, 2021; Mora et al., 2018; Cianconi et al., 2020). The impacts of climate change on mental health can be both direct and indirect and can range from short-term to long-term effects. It is well established that climate change can lead to the development of well-known psychopathological patterns. (Cianconi et al., 2020) Health-related behaviours are also impacted by climate change (Chevance et al., 2022). Addressing these challenges is essential for the survival of species and human health (World Health Organization, 2021; McLean et al., 2022).

Many authors emphasize the need for immediate emissions reduction to minimize health impacts (Mora et al., 2018; Ripple et al., 2021). The IPCC highlights the importance of

both adaptation and mitigation strategies in addressing climate change (IPCC, 2014; IPCC, 2021).

Balancing the promotion of human health and sustainable practices can be challenging, and changing behaviour is a crucial factor in achieving this objective. (Newell et al., 2021) Ultimately, there is a pressing need for individuals to adopt environmentally responsible behaviours (e.g recycling).

Recycling serves as a critical strategy to combat climate change, offering mitigation and adaptation benefits (IPCC, 2014). Despite its global significance, Portugal faces challenges with one of the lowest recycling rates in Europe (European Environment Agency, 2020; Eurostat, 2021). Understanding recycling behaviour requires a multifaceted approach, exploring the interplay of psychological, social, economic, and environmental factors (Smith et al., 2020).

Health psychology, specifically behaviour change models such as the Capability, Opportunity, Motivation, and Behaviour (COM-B) model, can provide valuable insights into the barriers and facilitators of recycling behaviours (Michie et al., 2011). Derived from the COM-B model, the Behaviour Change Wheel offers an evidence-based tool for promoting behaviour change, emphasizing the importance of tailored interventions to address deficits in capability, opportunity, and motivation (Michie et al., 2011).

Studies about the determinants of recycling behaviours in Portugal are limited. The present study will contribute to increase existing knowledge of the factors associated with recycling behaviours amongst higher education students in Portugal. This study will adopt the COM-B model to comprehensively examine multiple factors that influence recycling behaviours.

Literature review

Recycling Behaviour

Recycling plays a crucial role in combating climate change as both a mitigation and adaptation strategy. It reduces waste sent to landfills, mitigating greenhouse gas emissions, and encourages resource reuse, reducing demand for virgin materials (IPCC, 2014). Globally, recycling is integral to waste management and resource conservation.

Environmental psychology and sustainability research have explored factors influencing recycling behaviour, revealing a complex interplay of psychological, social, economic, and environmental determinants.

Recycling is essential for environmental preservation and public health. It minimizes strain on natural resources, lowers greenhouse gas emissions, and addresses waste management and sustainability (Smith et al., 2020). Moreover, recycling reduces the energy-intensive processes for raw material extraction, aiding climate change adaptation and mitigation (Brown & Johnson, 2019). The recycling process also mitigates toxic waste contamination, improving air and water quality and reducing the adverse impacts of pollution on public health (Green et al., 2018). In essence, recycling promotes a sustainable future for both the environment and human health, making it a proactive choice for a cleaner and healthier future for present and future generations.

However, Portugal's recycling rate is among the lowest in Europe, as reported by the European Environment Agency in 2020. Despite producing a significant amount of waste per capita. (Eurostat, 2021) It is therefore crucial for individuals and policymakers to take active steps to increase the rate of recycling and promote a sustainable future.

To solve environmental problems, it's important to understand human behaviour as it plays a big role in it. Psychology and behaviour science has a vital role to play in understanding and promoting recycling. (Chevance et al., 2022; Gifford, 2014) Engaging in pro-environmental behaviours such as recycling will require changes in public policies and influencing behaviour through them can be quite challenging. (Ripple et al., 2021) By considering psychological factors that drive human behaviour in specific contexts, policy makers can create more effective policies. (Chevance et al., 2022; Dolan et al., 2012)

In order to effectively address the ongoing climate crisis, it is important to incorporate recycling into a comprehensive strategy and maximize its mitigation potential. By studying the

psychological and behavioural factors that influence recycling, we can gain insights into why some people are more likely to recycle and how to encourage others to do the same.

Health psychology and behaviour change models can provide valuable insights for comprehending and predicting recycling behaviours, as examples of human behaviours. Numerous studies have delved into recycling behaviours, initially focusing on environmental behaviours, household recycling, and theories like the Theory of Planned Behaviour. Research has expanded to explore past behaviour, habits, behaviour change, motivation, psychological factors, social influences, and more, enhancing our understanding of this multifaceted field. (Phulwani et al., 2020)

Psychological Factors Influencing Recycling Behaviour

Recycling behaviour is a complex phenomenon influenced by a variety of psychological factors. Researchers have explored these intricacies to gain a deeper understanding of what drives recycling actions. The idea that recycling is not a one-size-fits-all concept challenges conventional wisdom. Recycling behaviour comprises multiple dimensions, emphasizing the need for a multidimensional approach to understand it better (Kaiser & Wilson, 2004). Kaiser and Wilson (2004) underscore the multidimensional nature of recycling, suggesting that it involves not only environmental concerns, but also specific goals, intentions, and perceived difficulties associated with each step. Similarly, Ramayah et al. (2012) highlighted how perceived personal difficulties, such as time, space, and distance from recycling facilities, can negatively impact recycling behaviour. Miliute-Plepiene et al. (2016) also highlight the importance of convenience factors (i.e., presence or placement of recycling facilities). They found that interaction between convenience factors and norm-related factors (i.e., moral social and legal norms) was found to be significant, with the importance of moral norms decreasing as convenience factors increased.

The Theory of Planned Behaviour (TPB) proposed by Ajzen (1991) stands as one of the most widely used frameworks for understanding recycling behaviour. Self-identity, as discussed by Terry, Hogg, and White (1999), emerges as a significant predictor within the TPB. Those who strongly identify with recycling are more likely to intend to recycle. However, the influences on recycling behaviour extend beyond TPB. Kraft et al. (2005) delve into the role of perceived behavioural control, affective attitude, and social norms. Perceived Behavioural Control (PBC), represents an individual's belief in their capability to recycle. It encompasses perceived control, confidence, and perceived difficulty, all of which contribute to shaping an individual's recycling intention. Affective attitude, or one's emotional connection to recycling,

also significantly influenced recycling intention, as it can either motivate or inhibit recycling. Social norms, which encompass the perceived expectations and pressures arising from society or peer groups regarding recycling behaviour, are pivotal influencers (Kraft et al., 2005). When individuals perceive that their social circle expects them to recycle, they are more motivated to align their behaviour with these expectations. Still within the TPB, a meta-analysis conducted by Bamberg and Möser (2007) further reinforces the importance of psychological variables in shaping pro-environmental behaviour, including recycling. Attitude, behavioural control, and personal moral norms were identified as significant predictors.

Nevertheless, it's worth noting that factors influencing recycling behaviours go beyond the TPB framework. Kaiser and Wilson (2004) discuss the issue of the attitude-behaviour alignment, particularly in the context of conservation behaviour. While it questions the extent of the so-called attitude-behaviour gap, it underscores the role of motivation in bridging this gap. Other authors have tried to explore beyond the model's limitations in a creative way. Park and Ha (2014) applied TPB to investigate recycling behaviour and incorporated Norm Activation Model (NAM), highlighting the dynamic relationship between the two models. TPB emphasizes the role of individual attitudes, subjective norms, and perceived behavioural control. In contrast, NAM emphasizes the importance of personal moral norms and the awareness of consequences in motivating pro-environmental behaviours like recycling. Additionally, Botetzagias et al. (2015) expanded the TPB by examining moral norms and the influence of demographic variables on recycling intentions. Their findings revealed how moral norms interact with the standard TPB predictors, increasing the explained variance of recycling intentions.

Ramayah et al. (2012) explored various factors within TPB, emphasizing the impact of environmental awareness, attitude, social norms, convenience, and cost. These factors collectively influence recycling behaviour, with attitudes and perceived behavioural control playing significant roles. Fan et al. (2019) proposed a comprehensive "Motivation-Intention-Behaviour" model based on TPB, which considers motivational, contextual, and habitual dimensions in understanding recycling behaviour. The integration of these dimensions provides a structured framework for analysing household solid waste sorting behaviours.

The work of Linder et al. (2021) discusses the limitations of attitude-behaviour models in predicting pro-environmental behaviour and emphasizes the importance of considering external factors. Their study found that physical manipulations, such as the placement of recycling bins and the presence of prompts, played a more significant role in recycling

behaviour than self-reported internal factors. This emphasizes the influence of the physical environment on recycling actions. Social norms and self-identity play critical roles in shaping recycling behaviour (Nigbur et al., 2010). Descriptive and injunctive social norms significantly influence intentions and actions regarding recycling. Additionally, an individual's self-identity, specifically their degree of self-identification as recyclers, is another influential factor (Terry et al., 1999).

These studies collectively reveal the interplay of factors influencing recycling behaviour. They emphasize the multifaceted nature of recycling decisions, highlighting how personal beliefs, social norms, and environmental actions intersect to influence recycling behaviour.

Social and Cultural Factors Influencing Recycling Behaviour

Recycling behaviour is influenced by social and cultural factors, not just individual psychology. Socio-cultural elements influence recycling behaviour, highlighting the impact of societal norms, policies, and collective values on individuals' willingness to recycle.

Oreg and Katz-Gerro (2006) explored cross-national influences on pro-environmental behaviour, recognizing the importance of cultural variations in recycling practices. They found that recycling norms and behaviours vary across countries due to specific cultural contexts, with country-level values, particularly post materialism, significantly affecting individual environmental concern and, in turn, behavioural intentions. The study suggests the need to consider cultural diversity in designing recycling interventions and policies. Hopper and Nielsen (1991) delved into the altruistic dimension of recycling, revealing how social factors, like the desire to benefit others or contribute to the community, motivate recycling actions. Their research emphasized the role of social norms and community influence in promoting recycling behaviours. Moreover, social norms, including personal, social, and legal factors, significantly impact recycling behaviour. (Miliute-Plepiene et al., 2016) The presence of perceived moral obligations and adherence to these norms motivates individuals to recycle, while government policies, economic incentives, and convenient recycling facilities influence recycling practices (Hage et al., 2009).

Collectively, these studies underscore the pivotal role of social and cultural factors in recycling behaviour, emphasizing that recycling is intricately connected to the values and norms of a community or country. Societal norms and values, as well as policies and collective values, have been identified as significant influencers of recycling behaviour.

Environmental Awareness and Knowledge

Recycling behaviour is closely tied to individuals' environmental awareness and knowledge, with numerous studies emphasizing their pivotal role in motivating recycling behaviours. Recyclers, as identified by Vining and Ebreo (1990), possess more accurate knowledge about recycling programs and materials, and they are driven by altruistic motives and social influence. Environmental awareness and knowledge play a vital role in shaping recycling behaviour, as evidenced by several studies. Ramayah et al. (2012) conducted research among university students and found that those with a deeper understanding of environmental issues tend to have more positive attitudes toward recycling. This underscores the importance of knowledge in fostering pro-recycling attitudes. Moreover, subjective norms, which reflect perceived social pressure to recycle, were shown to considerably impact recycling behaviour, highlighting the influence of social factors in this context. Convenience and the accessibility of recycling infrastructure were also identified as significant factors affecting recycling behaviour. In addition to this, a study showed that awareness of consequences positively influences personal norms and attitudes toward recycling, thereby contributing to shaping individual attitudes and norms. (Park and Há, 2014) Matthies et al. (2012) emphasized the significance of personal and social norms in recycling behaviour and highlighted the role of awareness of recycling's need and consequences, closely tied to environmental knowledge. Furthermore, Garcés et al. (2002) found that environmental awareness and knowledge of the environmental impact of waste positively influence recycling behaviour, particularly among those who have a favourable perception of local government waste management practices.

Additionally, Hopper and Nielsen (1991) explored the role of normative processes and interpersonal communication in community recycling programs, emphasizing the influence of social norms and cues, which can significantly affect recycling behaviour, driven by environmental awareness and knowledge. Building upon this, authors suggest that a comprehensive understanding of the environmental problematics of recycling and raising awareness may significantly promote recycling behaviour, (Valle et al., 2005; Hage et al., 2009) especially in early-stage recycling schemes (Miliute-Plepiene et al., 2016) since awareness of the negative consequences of not recycling, was an important motivator for household recycling behaviour. Moreover, Ölander and Thøgersen (1995) found lack of knowledge or understanding can lead to incorrect behaviour, even when information is provided.

These research findings, explain the pivotal role of environmental awareness and knowledge in shaping recycling behaviour. Knowledge not only contributes to shaping attitudes and personal norms but also fosters a heightened awareness of the consequences of recycling actions. In essence, it acts as a catalyst for pro-environmental behaviour.

Motivation and Goal-Directed Behaviour

Motivation plays a pivotal role in shaping recycling behaviour, as demonstrated in several studies. In a study that divided participants into two groups - recyclers and non-recyclers - both groups displayed motivation rooted in environmental concerns. Notably, non-recyclers exhibited a stronger inclination toward motivation driven by incentives, rewards, and personal convenience factors (Vining & Ebreo, 1990). Gilli et al. (2018) findings suggest that motivation impacts recycling behaviour. Specifically, individuals who are extrinsically motivated, meaning they are motivated by external rewards or incentives, are more likely to engage in recycling. On the other hand, intrinsic motivation, which comes from an inner need to perform an action or adopt a certain behaviour, did not have a significant impact on recycling behaviour. Policies improving the convenience of recycling, such as curbside and bring site facilities, encouraged recycling behaviour among individuals with both intrinsic and extrinsic motivations. This research emphasized the vital role of motivations in the success of waste management policies and the interaction between policies and individual's motivations in achieving meaningful waste reduction. The study conducted by Ölander and Thøgersen (1995) underlined the importance of altruistic motivation, primarily the motivation to protect the environment, as a key factor influencing recycling behaviour. These authors also mention that studies show that as individuals gain experience with recycling, their attitudes and willingness to recycle improve. This study highlighted the role of convenience and accessibility in influencing recycling behaviour. The authors also discuss that economic incentives alone are not effective in changing behaviour, and extrinsic rewards may undermine intrinsic motivation for environmentally friendly behaviour.

Kaiser and Wilson (2004) provided valuable insights into motivation within the context of recycling, emphasizing goal-directed performance. Recycling behaviour is inherently goal-oriented, driven by individuals' specific environmental objectives. Motivation is integral to setting and achieving these goals, aligning positive environmental attitudes with proactive recycling actions. Recycling is a multiple step behaviour, and each step will be associated with perceived barriers and or facilitators.

Furthermore, studies show that recycling behaviour is also significantly shaped by habits and past actions (Ölander and Thøgersen, 1995; Ouellette and Wood, 1998). Well-practiced behaviours, often in stable contexts, become habitual and influence future performance. Those with firmly established recycling habits are more inclined to sustain their recycling efforts. Deliberate, conscious decision-making may be necessary in situations where recycling habits are not deeply ingrained (Ouellette and Wood, 1998). Fan et al. (2019) highlighted the significance of habit formation in promoting sustained recycling, and they introduced the "Motivation-Intention-Behaviour" model, which integrates motivational, contextual, and habitual factors. Habit's influence on recycling behaviour should not be disregarded. Additionally, motivation is subject to variation due to external factors that can impact internal factors, either augmenting or diminishing the likelihood of a behaviour occurring.

Recycling Programs and Barriers to Recycling Behaviour

Oluwadipe et al. (2021) investigated UK household recycling. This article serves as a compelling illustration of how recycling behaviour should be comprehensively studied on a national scale to enhance and augment recycling rates. In a vast recycling behaviour study, researchers comprehensively explored an intricate web of factors that impact individuals' recycling behaviours. This exhaustive examined infrastructure-related barriers, economic considerations, social and cultural influences, the efficiency of recycling programs, policy effects, and the complex relationship between attitudes and recycling behaviour. It unveiled the collective interplay of these multifaceted elements, underlining the need to consider these diverse factors when promoting pro-environmental behaviours such as recycling. The study identified obstacles, including infrastructure limitations, cost, social factors, and policy constraints. Infrastructure issues, like limited access and unclear guidelines, hinder recycling. Economic factors, such as recycling costs, deter participation. The study also suggests that social and cultural factors significantly influence recycling behaviour. Aligning with cultural values and social identity motivates recycling, while social norms can encourage or discourage it. Authors suggest that efficient recycling programs require user-friendly infrastructure, reliable collection, and public engagement. Policies like incentives have limited impact. Furthermore, generational differences should be considered. Lastly, the relationship between attitudes and recycling is complex. Convenience, knowledge, social influences, and past behaviours affect recycling. Barriers like time, effort, and perceived inconvenience can outweigh attitudes.

Recycling behaviour is a multifaceted process influenced by psychological, social, and environmental factors. It encompasses individual beliefs, attitudes, motivations, and the influence of social norms and cultural factors. The interplay of motivations and goal-directed behaviour highlights the deliberate choices individuals make regarding recycling activities. Recycling programs and policies can introduce barriers or facilitate recycling, ultimately encouraging more sustainable practices. (Oluwadipe et al., 2021)

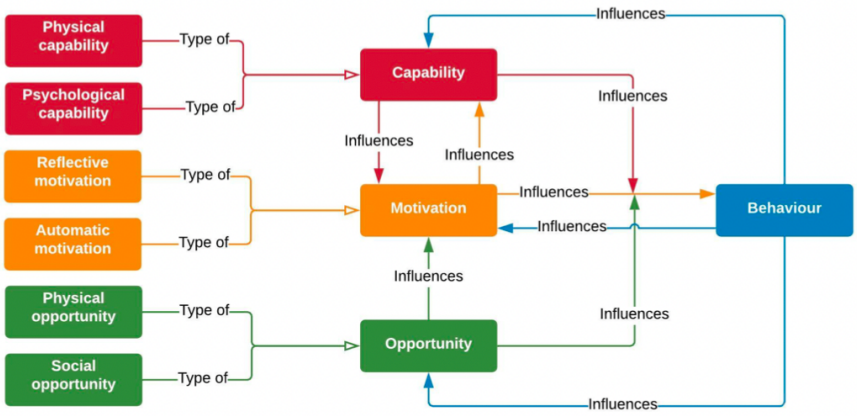
In summary, addressing recycling barriers requires a multi-dimensional intervention strategy, involving comprehensive policy reviews, improved communication, integrated planning for recycling programs, and efforts to overcome the various factors that influence recycling behaviour. Well-structured infrastructure, reliable service quality, and tailored policies are essential to boost recycling rates and promote sustainability. Recycling, being a multifaceted behaviour, necessitates a holistic approach that acknowledges its social and goal-oriented nature, entailing perceived facilitators and barriers that are inherently influenced by motivation. Additionally, it is profoundly shaped by guidelines and local governmental policies.

The COM-B model

The COM-B model stands out as a prominent integrated framework designed to understand behavioural determinants and facilitate behaviour change. The UK National Institute for Health and Care Excellence, recognizes the COM-B model as a key theoretical structure for comprehending and supporting behaviour change. The model was constructed based on diverse health behaviour models such as health belief model, theory of planned behaviour, self-determination theory, among others (Michie et al., 2011).

Figure 1

COM-B model of behaviour – a Framework to understand behaviour. Source: West and Michie (2020)



The model suggests that behaviour results from three factors: Capability, Opportunity, and Motivation (Michie et al., 2011).

Capability refers to the ability of actually performing the behaviour. This includes both the physical ability (e.g., mobility, dexterity) and the psychological referring to the ability to engage in the cognitive processes necessary for the behaviour, such as reasoning and understanding. (e.g., knowledge, self-esteem,).

Opportunity encompasses external factors referring to the availability of necessary resources to perform the behaviour. Physical opportunity refers to the external factors in the environment that make it possible for an individual to engage in a specific behaviour such as time, resources, and the physical environment itself. Social opportunity to the interpersonal and social influences that affect an individual's ability to engage in a specific behaviour such as one's social context, social norms, and interactions.

Motivation refers to the drive to engage in behaviour based on personal values, beliefs, attitudes, and emotions. It encompasses all internal processes influencing decision-making and behaviour. Reflective motivation refers to the conscious intentions and thoughtful processes involved in planning and decision-making. It encompasses the deliberate and reasoned aspects of motivation where individuals actively consider their goals, values, and intentions before engaging in a behaviour. On the other hand, automatic motivation involves processes that occur more instinctively and spontaneously. The COM-B model proposes a holistic view of behaviour. It recognizes that behaviour is not only influenced by individual factors, but also by opportunities and resources available in the individual's environment. It has also been developed through a comprehensive effort to synthesize various existing models into a single and integrated framework.

The authors recognize that changing human behaviour is crucial to meeting the challenges facing society, including the climate emergency. It states that the COM-B model has been developed to assist with identifying appropriate targets for behaviour change interventions in order to address issues like our current climate emergency. The model proves to be an integrative and efficient theoretical framework for analyzing behaviors. As a model that delineates various components associated with the change in specific behaviors it enables a deeper understanding of these behaviors and their influencing factors. (West & Michie, 2020). It is therefore a promising tool to understanding and explaining recycling behaviour.

In the specific context, of recycling behaviour in Portugal, the model considers various factors that could influence behaviour. For example, individual's capability to recycle may be influenced by their physical ability to separate recyclables, their knowledge about what can be recycled, and their access to recycling facilities. The opportunity to recycle in Portugal could be influenced by the availability of recycling facilities and the presence of recycling programs. Meanwhile, a person's motivation to recycle may be influenced by their concern for the environment or their sense of personal responsibility. This theoretical framework provides us with an interesting way of studying Portuguese recycling behaviour because it recognizes the complex interplay of individual, environmental, and psychological factors that influence this behaviour. By recognizing the complexity of these factors and the ways in which they interact with each other, the model provides a valuable tool for understanding and promoting effectively recycling behaviour.

Understanding Recycling through the COM-B Model

Recycling behaviour is multifaceted and influenced by various factors. The COM-B model is a comprehensive approach by incorporating the dimensions of Capability, Opportunity, and Motivation. Unlike studies that often narrow their focus to specific psychological factors, the COM-B model considers a broader spectrum of influences on behaviour, encompassing both individual internal factors and external elements.

The Theory of Planned Behaviour (TPB), very frequently employed to assess psychological factors related to recycling (Phulwani et al., 2020), is a theory that is integrated into the COM-B model. (Michie et al., 2011)

Various studies exploring psychological factors related to recycling, such as those by Nigbur et al. (2010), Kraft et al. (2005), offer insights that can be related to the COM-B model. For instance, the significance of perceived behavioural control, as emphasized in these studies (i.e., an individual's belief in their ability to perform recycling behaviour), aligns with the COM-B model's capability component.

Furthermore, Park and Ha's (2014) study about personal moral norms finds resonance within the COM-B model, particularly through its reflexive motivation and social opportunity component. This facet considers the alignment of personal values and beliefs with moral norms, providing a framework for comprehending the impact of these individual factors on recycling behaviour.

The assessment of task difficulty constitutes a crucial psychological factor in recycling behaviours. Oluwadipe et al. (2021) highlight the significance of perceived personal difficulties, such as time, space, and distance from recycling facilities, in potentially undermining recycling efforts. Additionally, authors like Ölander & Thøgersen (1995) and Ramayah et al. (2012) discuss the impact of convenience, including proximity to recycling facilities, on recycling behaviour. External factors such as the strategic placement of recycling bins and prompts are also identified as influential elements (Linder et al., 2021). Notably, all these factors align with the COM-B model's physical opportunity component.

Various studies underscore the importance of social and cultural factors in recycling behaviour, emphasizing that recycling is connected to the values and norms of a community or country. Societal norms and values, as well as policies, have been identified as significant influences of recycling behaviour (Hopper & Nielsen, 1991; Hage et al., 2009; Oreg & Katz-Gerro, 2006). The COM-B model, especially through its social opportunity component, acknowledges the profound impact of external influences and societal context on behaviours.

Moreover, altruistic behaviour, as highlighted in Hopper and Nielsen's research, is identified as an important element in recycling behaviour. The COM-B model, particularly through its Motivation component, acknowledges the significance of altruism as a factor influencing behaviour. Additionally, authors argue that perceived moral obligation is a noteworthy factor (Hage et al., 2009), aligning with the social opportunity component within the COM-B model.

Environmental awareness and knowledge play a significant role in shaping recycling behaviour. Knowledge not only contributes to shaping attitudes and personal norms but also fosters a heightened awareness of the consequences of recycling behaviours. In essence, it acts as a catalyst for pro-environmental behaviour. (Vining & Ebreo, 1990; Ramayah et al., 2012)

Within the framework of the COM-B model, environmental awareness and knowledge align with the Capability component. Capability encompasses both the psychological aspect, represented by environmental awareness, and the cognitive aspect, embodied by knowledge. Individuals who have a comprehensive understanding of environmental issues, recycling programs, and materials may exhibit heightened capability in engaging in recycling behaviour. Their awareness extends beyond mere comprehension of environmental repercussions, encompassing practical knowledge essential for effective participation in recycling programs. The importance of understanding the consequences of behaviour, as outlined by Park and Ha

(2014), further underscores the significance of these capabilities. Authors, suggest that individuals with a deeper comprehension of environmental issues tend to manifest more positive attitudes toward recycling. The awareness of environmental consequences related to waste and recycling serves as a potent motivator, influencing personal norms and attitudes toward recycling. Consequently, environmental awareness and knowledge emerge as motivational factors that inspire and encourage recycling behaviour (Ramayah et al., 2012). This resonates with the Reflective Motivation component as delineated within the COM-B model.

These findings point that environmental awareness and knowledge could encompass both the Capability and Motivation components of the COM-B model. Individuals with a higher level of environmental awareness and knowledge could not only possess the psychological capability to recycle effectively but could also be motivated to do so, driven by their understanding of the environmental impact and their positive attitudes toward recycling. This would suggest the pivotal role of these factors in shaping recycling behaviour.

Research demonstrates that recycling behaviour is significantly shaped by established habits and past actions. Behaviours that are well-practiced, especially in stable contexts, tend to become habitual, with a considerable influence on future performance. Individuals who have ingrained recycling habits are more likely to consistently participate in recycling efforts. Conversely, in situations where recycling habits are not deeply rooted, intentional and conscious decision-making may be necessary, as proposed by Ouellette and Wood (1998). Fan et al. (2019) emphasized the importance of habit formation in fostering sustained recycling behaviours. This perspective aligns with the concept of automatic motivation in the COM-B model.

Ölander and Thøgersen (1995) highlight that the motivation to protect the environment is an essential factor influencing recycling behaviour. This aligns with the reflective motivation component in the COM-B model. The influence of habits on recycling behaviour is also important, aligning with the automatic motivation component in the COM-B model. Moreover, motivation is dynamic and subjected to variations caused by external factors that can impact internal factors, either enhancing or diminishing the likelihood of a behaviour occurring. Ultimately, motivation emerges as a central driving force shaping recycling behaviour, interacting with various factors such as policies, and environmental concerns, to foster pro-environmental behaviours like recycling.

Lastly, addressing recycling barriers demands a multi-dimensional intervention strategy, encompassing policy reviews, enhanced communication, integrated planning, and efforts to overcome influencing factors. Essential for boosting recycling rates are well-structured infrastructure, reliable service quality, and tailored policies, emphasizing the need for a holistic approach considering the social and goal-oriented nature of recycling behaviour. This approach recognizes perceived facilitators and barriers inherently influenced by motivation. Additionally, it is profoundly shaped by guidelines and local governmental policies. (Oluwadipe et al., 2021) As previously mentioned, the COM-B model provides the necessary holistic framework to assess complex behaviours.

Ultimately, the COM-B model provides a comprehensive and integrated perspective on the multifaceted influences shaping recycling behaviour. The model integrates external factors, ranging from societal norms and values to cultural diversity, altruistic behaviour, legal norms, and government policies, alongside internal factors. This comprehensive framework maintains specificity while acknowledging the interconnectedness of external influences and their interaction with intrinsic factors such as individual capabilities, opportunities, and motivations. The model thus provides a holistic and nuanced understanding of recycling behaviour.

Portuguese Context

A few studies have been conducted exploring recycling behaviour in Portugal. Findings have provided insights into the factors that influence individuals' willingness to recycle. A study conducted in 2021, examined the perceptions of sustainable development among students at a Portuguese public higher education institution. Results showed that most students recognize the importance of sustainable development, habits, and behaviours, such as reusing, reducing, and recycling. Portuguese higher education students recognize the importance of sustainable development but feel that their institutions should do more to teach it. Most students engaged in pro-sustainability habits like recycling, but fewer participate in organized sustainability activities. The study identified four clusters of students based on their perception of sustainable development, with the largest cluster actively contributing to sustainability. The research analyses the perceptions and practices of Portuguese university students related to sustainable development. It categorizes the data into factors such as Reuse and Reduce, Climate Change Concerns, Activities Organized by higher education institutions in the sustainable development Area, Contributing to Environmental Protection, and Recycling. It identifies differences in responses based on age, gender, and scientific area,

highlighting the importance of tailoring sustainability education to diverse student groups. Most students believe that their universities could provide more comprehensive training on sustainable development. Some topics are covered more extensively in degree courses, such as accountability and ethics, cultural diversity, and human rights, while others, like ecosystems and ecological principles, receive less attention. Students express a willingness to make changes in their lifestyles to help the environment, but there are notable variations in beliefs and attitudes towards sustainable development based on age groups and scientific areas. In summary, Portuguese higher education students value sustainable development, but they want their institutions to be more involved in teaching and promoting it. This research emphasizes the significance of understanding students' perceptions and behaviours in fostering sustainability in higher education. While previous studies have examined students' attitudes, behaviours, and competencies related to sustainability, the study suggests there is still a lack of institutional and curriculum support for sustainability education. More research is needed to understand the perspectives of students and teachers in various fields and contexts. (Aleixo et al., 2021)

A study also conducted with higher education Portuguese students found that “environmental attitude and knowledge” have no significant impact on pro-environmental intention. On the other hand, subjective norm and perceived behavioural control had a positive impact on their pro-environmental intention. The study concluded that students’ perceived behavioural control and pro-environmental intention was what significantly predicted pro-environmental behaviour. (Correia et al., 2021)

Another study has found that household propensity to participate positively correlates with available space for recyclable materials, strong positive attitudes toward recycling, and high satisfaction with the selective-collection system's logistics. Conversely, households where respondents find recycling difficult or express indifference exhibit a negative propensity to engage in recycling, with "difficulty or indifference" being a significant explanatory variable.

To improve recycling participation, the study recommends enhancing the performance of the consumer logistics service of the selective-collection system. This includes evaluating aspects such as the location of disposal containers, support and claim services availability, and the provision of general information. Respondents from nonadherent households consistently report lower satisfaction with these logistics service elements. The study’s findings recycling is not determined by general ecological attitudes regarding the environment but rather by a broader spectrum of personal and social factors. (Valle et al., 2005)

Additionally, a recent study explored the impact of socio-economic and political factors of recycling rates in Portuguese municipalities. The level of education, income, and political orientation of the municipality was found to significantly impact the rate of recycling. In Portuguese municipalities from 2009 to 2017, research suggests that recycling performance is positively associated with factors such as the primary sector, the presence of older generations, and financial consolidation periods. However, it tends to decline in election years and when the executive in the Town Council and the Municipal Assembly shares the same political ideology. These results indicate that recycling adapts rapidly to reach desirable levels, reflecting a swift learning process. Consumer behaviour also plays a role in recycling outcomes. Environmental concern is positively related to recycling, as is the choice to consume environmentally friendly products. Moreover, the connection between political beliefs and environmental issues intensifies with higher education levels, emphasizing the complex interplay of socio-economic and political factors on recycling behaviour.

While examining the economic and demographic characteristics of Portuguese municipalities, it was found that the tertiary sector dominates production, while population density varies significantly across regions, and some areas have a higher proportion of elderly residents. These demographic and economic variances impact recycling levels, underlining the need for tailored recycling strategies. These findings collectively emphasize the importance of considering a range of socio-economic and political factors when implementing and assessing recycling policies in Portuguese municipalities, with the goal of improving recycling performance and environmental sustainability. Furthermore, they highlight the need for ongoing research to better understand the complex relationships between these variables and recycling outcomes. The authors recommend that policymakers develop programs targeting specific socio-economic and political characteristics of each municipality in order to increase recycling rates. (Cerqueira & Soukiazis, 2022)

However, there are many other factors that influence pro-environmental behaviour, including childhood experiences, education, personality, perceived control, values, attitudes, responsibility, attachment to place, habits, goals, emotions, and demographic factors, which can interact and have a combined effect on behaviour. It is no different for recycling since it is too a complex behaviour influenced by a variety of factors, including individual attitudes, social norms, and the physical and psychosocial environment. (Gifford, 2014)

To summarize, on one hand, recycling is a crucial component in promoting environmental preservation and public health. It plays a vital role in reducing the strain on

natural resources and limiting greenhouse gas emissions, which contributes to addressing the issue of waste management and promoting sustainability. Choosing to recycle, is an active step towards a cleaner and healthier future for ourselves and generations to come.

On the other hand, there's recycling as a behaviour, a multifaceted and action, influenced by numerous interconnected factors and determinants. Many studies collectively emphasize that to effectively bring about behaviour change and promote recycling, one must consider a complex web of psychological, social, cultural, and structural influences. This includes individuals' psychological factors, such as attitudes, motivations, and environmental awareness that influence recycling decisions. Additionally, social, and cultural norms, as well as external factors like economic incentives and recycling programs, exert considerable influence on the choices individuals make. These elements are not isolated but intertwined. A comprehensive approach to address the complexities of recycling behaviour and to formulate targeted strategies for fostering sustainable practices, is needed.

As previously noted, Portugal has one of the lowest recycling rates in Europe, a finding reported by the European Environment Agency in 2020. This situation persists despite the nation's considerable per capita waste production, as confirmed by Eurostat's 2021 findings. It is therefore there is a pressing need for individuals and policymakers to collaboratively take active steps to increase the rate of recycling and promote a sustainable future.

Aim of the study:

The aim of this study is to comprehensively explore recycling behaviors, specifically focusing separately on the frequency of separation and disposal behaviours and their corresponding determinants. We want to systematically assess recycling behaviors through a developed questionnaire, focusing on the frequency of separation and disposal behaviors and their determinants from the COM-B model. Firstly, we would like to assess recycling behaviours tendencies, by assessing the frequency of separation and of disposal behaviours for different recyclable waste categories. Second, we want to explore the associations between separation behaviour frequency and its COM-B determinants, as well as the associations between disposal frequency and its corresponding determinants. Lastly, we intend to identify the key determinants that significantly predict separation and disposal behaviours.

Research Objectives: *(1)* Assess the frequency of separation behaviours for different recyclable wastes; *(2)* Assess the frequency of disposal behaviours in different recyclable wastes; *(3)* Analyse the associations between separation behaviours frequency and COM-B

determinants; *(4)* Analyse the associations between disposal frequency behaviours and COM-B determinants; *(5)* Explore and identify determinants of separation behaviours based on the COM-B model; *(6)* Explore and identify determinants of disposal behaviours using the COM-B model.

Methods

Study Design

This research employed a quantitative and cross-sectional study design. Data was collected through an online self-report questionnaire, collected at a single time point.

Participants

Participants were recruited from a convenience sample of university students. The inclusion criteria for participation were as follows: (1) Reside in Portugal and be fluent in Portuguese, (2) current enrolment as a university student, and (3) willingness to provide informed consent to participate in the study.

Table 1 presents the main characteristics of the sample. The sample consisted of 195 participants with an average age of 24 (SD=7,23; Min=17, and Max=70). The sample was predominantly composed of female individuals, representing 69.7% of the participants (n=136), there were 49 male participants representing 25.1% of the participants, and 10 participants identified as non-binary (5,1%). There was a strong geographical concentration in the Lisbon region, with 106 participants (54,4%). The areas with less participants were Bragança, Leiria, Portoalegre, Vila Real and Viseu with 1 participant each. The most prevalent fields of study in the sample were Humanities (18.2%), Social Sciences (17.6%), Engineering (15.5%), Linguistics, Literature, and Arts (9.6%), Health Sciences (9.1%), and Biological Sciences (8.6%). The remaining fields of study constituted less than 5% of the sample.

Table 1
Sample Characterization with participant's Sociodemographic Variables.

Variables	**Frequency (N=195)**	**Percentage (%)**
Age	(n= 167)	
17-25	143	80,8%
26-36	26	14,7%
40 and above	8	4,5%
Gender	(n= 195)	
Female	136	69,7%
Male	49	25,1%
Nonbinary	8	4,1%
Other	2	1.0%

Residence district	(n= 195)	
Aveiro	5	2.6 %
Braga	3	1.5 %
Bragança	1	0.5 %
Castelo Branco	2	1.0 %
Coimbra	14	7.2 %
Faro	8	4.1 %
Leiria	1	0.5 %
Lisboa	106	54.4 %
Portalegre	1	0.5 %
Porto	33	16.9 %
Setúbal	19	9.7 %
Vila Real	1	0.5 %
Viseu	1	0.5 %
Fields of study	(n=187)	
Architecture	3	1,60%
Agricultural Sciences	2	1,07%
Biological Sciences	16	8,56%
Exact and Earth Sciences	9	4,81%
Humanities	35	18,72%
Social Sciences	33	17,65%
Health Sciences	17	9,09%
Technological Specialization Course	6	3,21%
Interior Design	1	0,53%
Law	6	3,21%
Economics	2	1,07%
Engineering	29	15,51%
Finance	2	1,07%
Linguistics, Letters, and Arts	18	9,63%
Languages and Business Relations	1	0,53%
Aviation	1	0,53%
Marketing and Advertising	3	1,60%
Management	2	1,07%
“Student”	1	0,53%

Instruments

Socio-Demographic characteristics

Participants were asked to provide information about their age, gender, district of residence, and area of study.

Frequency of recycling behaviours

Participants were asked about the frequency in which they recycled various types of waste, with separate questions for "separation" and "disposal" of recyclable waste. The questionnaire was built for the purpose of this research and used a 6-point response scale: 'nunca' (never), 'raramente' (rarely), 'às vezes' (sometimes), 'muitas vezes' (often), 'quase sempre' (almost always), and 'sempre' (always). Six items asked about the separation of recyclable waste (e.g., Separation of glass packaging for recycling) and five items about the disposal (e.g., Dispose of metal packaging in appropriate recycling containers). Scores for each set of questions resulted from the computed average.

Determinants of recycling behaviours

An adapted version of the short version of the COM-B questionnaire was used. (Keyworth et al., 2020) Keyworth and colleagues (2020) developed a questionnaire to assess behaviour determinants from the COM-B model. The questionnaire indicated high acceptability, with missing data ranging from 5.9% to 7.7% at baseline and 18.1% to 32.5% at follow-up. The reliability, as measured by Intraclass Correlations, ranged from .554 to .833. Validity was supported by low floor effects (0.6% to 5.5%) and ceiling effects (4.1% to 22.9%), along with pairwise correlations that were significantly below 1.0. Regression models utilizing the questionnaire accounted for a substantial proportion of the variance in behaviour, ranging between 21% and 47%. Confirmatory Factor Analysis employing a three-factor model demonstrated a good fit: $\chi 2$ (6) = 7.34, p = .29, RMSEA = .02, CFI = .99, TLI = .99, BIC = 13,510.420, AIC = 13,428.067. Results suggest that the newly developed questionnaire exhibits strong evidence of acceptability, validity, and reliability, making it a valuable tool for self-assessment of COM-B determinants.

The questionnaire developed for this study was designed to assess the determinants involved in each of the recycling behaviours (separation and disposal), in 6 categories: Psychological Capability, Physical Capability, Physical Opportunity, Social Opportunity, Reflective Motivation, and Automatic Motivation. For separation there were a total of 15 questions and for disposal 17 questions. The complete questionnaire is provided in Appendix 1. Participants responded on a Likert type scale ranging from "Strongly Disagree (1)" to "Strongly Agree (7)."

Separate mean scores were computed for each category separately for separation and for disposal behaviours.

Separation Determinants. Psychological Capability: 3 questions, (items 12 to 14, e.g. I have sufficient knowledge to know how to correctly separate recyclable waste.); Physical Capability: 1 question (item 15, I am physically capable of correctly separating recyclable waste.) ; Physical Opportunity: 2 questions (items 16 and 17, e.g., I have sufficient space at home to separate and store recyclable waste.); Social Opportunity: 4 questions (items 19 to 22, e.g .The separation of recyclable waste is valued by my community.); Automatic Motivation: 1 question (item 23, Separating waste for recycling is a habit that is already ingrained in my routine.); Reflective Motivation: 4 questions (items 24 to 27, e.g. I believe that it is important to separate recyclable waste for society, future generations, the environment, etc.)

Disposal Determinants. Psychological Capability: 2 questions (items 33 and 34, e.g., I know where to dispose of recyclable waste.); Physical Capability: 1 question (item 35, I am physically capable of taking recyclable waste to selective collection points.); Physical Opportunity: 3 questions (items 36 to 38, e.g. The selective collection facilities I have access to are conveniently located.); Social Opportunity: 4 questions (items 39 to 42, e.g Properly disposing of recyclable waste is valued by my community.); Automatic Motivation: 2 questions (items 43 and 44, e.g., Properly disposing of recyclable waste in the appropriate locations is a habit that is already ingrained in my routine.); Reflective Motivation: 2 questions (items 45 and 49, e.g., I feel that I contribute to environmental preservation when I properly dispose of recyclable waste.)

Procedure

The questionnaire for this study was adapted to assess recycling behaviours and their determinants among university students in Portugal, based on the COM-B model. Comprehension and clarity of the questions were verified by the research team, including behavioural scientists and 3 experts in recycling behaviours. In addition, we conducted a short pilot study with 7 university students. Suggestions led to the reformulation, removal, and addition of questions in the questionnaire, refining it to enhance clarity and ensure a more accurate assessment of variables under investigation.

Data were collected through an online survey platform created with Microsoft forms, and participants were provided with informed consent information at the beginning of the survey, including information about the study's objectives and their rights as participants.

Informed consent was obtained from all participants, and their anonymity and confidentiality were ensured throughout the research process. The anticipated response time was around 10 minutes maximum, and the questionnaire's link was disseminated on social media through a snowball sampling approach, through convenience sampling.

Data Analysis

Data analysis was conducted using the Jamovi statistical software. (The *Jamovi* Project, 2022) We began by employing descriptive statistics to summarize the demographic characteristics of the sample, providing an overview of the participants' key demographic attributes. Additionally, we utilized descriptive statistics to present an overview of the characteristics of all other variables under investigation, allowing us to gain insights into the distribution and central tendencies of our data.

To ensure the robustness of the measures employed in our study, we conducted a reliability analysis using Cronbach's alpha for the items related to the behavioural determinants within the COM-B model. This analysis aimed to assess the internal consistency and reliability of our measurements. The analysis of internal consistency using Cronbach's alpha assesses whether items within specific categories reliably measures the same construct. (Cronbach & Meehl, 1955) George and Mallery (2003) (cited in Gliem, 2003) state that, generally, an alpha value above 0.7 is acceptable for most research purposes, while a value surpassing 0.8 is considered good, indicating a high level of internal consistency. Conversely, a value below 0.7 may suggest low internal consistency, warranting further investigation into the measure's reliability. It's crucial to recognize that the interpretation of Cronbach's alpha should be context-specific, considering the study's purpose, the number of items in the scale, and other factors like the research field and the construct being measured. (Cronbach & Meehl, 1955)

Psychometric sensitivity was assessed by examining the skewness and kurtosis coefficients of all quantitative variables. Values considered acceptable were skewness values ($|Sk| \leq 3$ and kurtosis values ($|Ku| \leq 10$, as recommended by Kline (2016). Q-Q plots of residuals (Appendix 2 – Figure 1 and Figure 2) were analysed to assess the normality assumption, examining whether the points form a linear pattern, indicating approximate normal distribution of the data.

To explore the relationships between recycling behaviour frequency and the composite scores for each COM-B determinant we conducted correlation analysis. Pearson’s correlation was used. This statistical approach allowed us to identify associations between these variables,

providing insights into how they relate to each other. The magnitude of the correlation coefficient was interpreted as follows: 0.00 - 0.19 indicates a very weak correlation, 0.20 - 0.39 signifies a weak correlation, 0.40 - 0.59 represents a moderate correlation, 0.60 - 0.79 indicates a strong correlation, and 0.80 - 1.00 reflects a very strong correlation. (Schober et al., 2018) We conducted two correlation analysis. The first was to investigate the bivariate associations between the frequency of separation of various waste, and each correspondent category of COM-B determinants. The other one, examined the associations between frequency of disposal of waste and each category of COM-B determinants specific to disposal.

To identify which determinants impact recycling behaviour frequency, stepwise regressions were conducted. In each regression the dependent variable (DV) was the separation behaviour frequency, and the independent variables (IV) were the COM-B determinants. Before proceeding with the regression analysis VIF values were assessed. As highlighted by James et al. (2013), in regression analysis multicollinearity becomes a significant concern when Variance Inflation Factor (VIF) values exceed 10, indicating a problematic level of multicollinearity, and values surpassing 5 should be scrutinized with caution. This assumption check is essential to maintain the integrity of the regression model and to ensure that the estimated coefficients are reliable and interpretable.

For these regressions, the stepwise procedure systematically added the independent variables one by one, unveiling their contributions to explaining the variation in separation behaviour frequency. There were six independent variables under consideration in the stepwise regression analysis. They were systematically introduced one by one, adhering to a sequential progression from a simpler model to a more complex one. This gradual process results in a model which incorporated all six COM-B determinants simultaneously. This final model served to test the combined impact of the entire set of determinants on the dependent variable. This statistical method helps identify which determinants significantly impact recycling behaviour while controlling for other variables. Two stepwise regressions were conducted, to examine separately separation and disposal behaviours. First, we examined the relationship between the frequency of separation behaviours and the corresponding composite scores for COM-B determinants. Second, we assessed the relationship between the frequency of disposal behaviours and the corresponding composite scores for COM-B determinants. Various key parameters were examined to provide a thorough assessment of the regression model. The R-squared value, indicating the proportion of variability explained in the dependent variable by the independent variables, was analysed to gauge the overall goodness of fit. Additionally, the

Beta coefficient, offered insights into the impact of each independent variable on the dependent variable. The significance of these relationships was evaluated through the p-value, with a predefined threshold set at 0.05. A p-value below this threshold signifies statistical significance. (James et al., 2013)

These analyses allowed us to explore the relationships between these variables and gain insights into the factors influencing recycling behaviours. Finally, we interpreted the results of our regression analyses to understand how the various COM-B determinants impacted the frequency of recycling behaviours. This analysis helped us uncover patterns and relationships within our data, shedding light on the factors influencing recycling behaviour in our study. This approach allowed us to systematically analyse our data and draw meaningful conclusions regarding the recycling behaviours and their determinants in our sample.

Results

To evaluate psychometric sensitivity, the values of skewness and kurtosis coefficients were examined for all quantitative variables. It was observed that their values met the required criteria. For COM-B determinants, QQ plots of residuals also suggest that the distribution of these variables can be considered as normal. (Appendix 2 - Figure 1 and Figure 2)

Recycling behaviours of separation

Frequency of separation of waste

The mean general score for waste separation was 3.60 Examining specific scores revealed a hierarchy in recycling frequency, with glass separation having the highest score (3.95), followed by paper/cardboard separation (3.76), plastic separation (3.84), metal separation (3.56), organic waste separation (3.45), and other waste separation (3.02) (Table 2). This indicates that glass was the most frequently separated recyclable, followed by paper/cardboard, plastic, metal, organic waste, and other waste.

Table 2

Descriptives of separation behaviours frequency.

	Minimum	Maximum	Mean	SD	Skewness	Kurtosis	N
Organic waste	1	6	3,45	1,68	0,124	-1,24	195
Plastic	1	6	3,84	1,61	-0,136	-1,19	195
Metal	1	6	3,56	1,59	0,0803	-1,18	195
Glass	1	6	3,95	1,68	-0,261	-1,21	195
Paper	1	6	3,76	1,58	-0,088	-1,12	195
Other waste	1	6	3,02	1,55	0,472	-0,746	195

Determinants of separation behaviours

Reliability analysis for separation determinants. Items assessing phychological capability, physical opportunity and reflexive motivation exhibited good internal consistencies indicating their reliability. Social opportunity has an acceptable value for internal consistency. While slightly lower than the previous determinants it still indicates reasonable internal consistency.

These internal consistency analyses provide evidence of the reliability of the grouped items within each category, ensuring that they reliably measure the respective COM-B determinants for separation behaviours.

Table 3
Reliability analysis - Cronbach's α for separation determinants.

	Items	**Cronbach's α**
Psychological capability	12, 13, 14	0,830
Physical capability	15	-
Physical opportunity	16, 17	0,836
Social opportunity	19,20,21, 22	0,769
Automatic motivation	23	-
Reflexive motivation	24, 25, 26,27	0,896

Table 4
Descriptives for separation COM-B determinants.

	Min	Max	Mean	SD	Skewness	Kurtosis	N
Psychological Capability	2	7	5,58	1,11	-0,664	0,151	195
Physical capability	2	7	6,48	0,954	-2,20	5,48	195
Physical opportunity	1	7	4,48	1,72	-0,277	-0,814	195
Social opportunity	1	7	4,20	1,35	0,0436	-0,526	195
Automatic motivation	1	7	4,45	1,98	-0,430	-1	195
Reflective motivation	1,25	7	5,60	1,31	-1,04	0,857	195

Correlation analysis. Psychological and physical capability, with respective correlation coefficient of 0.379 and 0.223, indicate a weak correlation with separation behaviour frequency. Physical opportunity, social opportunity, and reflective motivation with respective correlation coefficient of 0.565, 0.540 and 0.409, indicate a moderate correlation with separation behaviour frequency. Lastly, automatic motivation had a strong correlation coefficient of 0.730.

All the p-value for the correlation coefficients were found to be statistically significant ($p < 0.05$), indicating a low likelihood that the observed correlation occurred by random chance alone. (Appendix 2 – Table 7)

Regression analysis. Ensuring the absence of multicollinearity is a crucial step in regression analysis. Multicollinearity assumption check is essential to maintain the integrity of the regression model and to ensure that the estimated coefficients are reliable and interpretable. Upon analysis, the VIF values for my separation COM-B determinants were found to be less

than 5, reassuring that multicollinearity is not a significant issue in this study. (Appendix 2 – Table 10)

From step 2 onwards, each regression step significantly increased the explained variance (R-squared), except for step 6, where adding a determinant didn't contribute to the augmentation of R-squared. (Appendix 2 – table 9) This final model, incorporating all six determinants, has an R-squared value of 0.567, $F(6, 188)=41,0$; $p<.001$, but this model does not augment the explained variance. Therefore, it might be preferable to retain the regression model from step 5 without the inclusion of an additional determinant (Reflective Motivation). Regression model from step 5, incorporating five determinants has an R-squared value of 0.567 as well, $F(6, 188)=49,4$; $p<.001$. This indicates that approximately 56.7% of the variance in the separation behaviour frequency can be explained by the combined influence of the COM-B determinants.

Notably, while Physical Capability showed a marginal significance with $p = 0.053$, Automatic Motivation emerged as a highly significant determinant ($p < 0.001$) with a standardised beta coefficient of 0.423. Although the overall model explains a moderate amount of the separation behaviour frequency, the strong impact of Automatic Motivation is key to understanding it.

Table 5

Stepwise Regression Results for Predicting separation behaviour frequency using COM-B Determinants.

Model	Standardized coefficient Beta	*t*	Sig. (*p*)	R^2
Step 1				0,144
Psychological capability	0,379	5,69	<.001	
Step 2				0,147
Psychological capability	0,349	4,680	<.001	
Physical capability	0,066	0,884	0,378	
Step 3				0,343
Psychological capability	0,158	2,243	0,026	
Physical capability	0,022	0,336	0,737	
Physical opportunity	0,491	7,534	<.001	

Step 4				0,391
Psychological capability	0,085	1,202	0,231	
Physical capability	0,037	0,586	0,559	
Physical opportunity	0,347	4,755	<.001	
Social opportunity	0,286	3,897	<.001	
Step 5				0,567
Psychological capability	-0,002	-0.0297	0,976	
Physical capability	0,106	1.9497	0,053	
Physical opportunity	0,110	1.6283	0,105	
Social opportunity	0,089	1.3553	0,177	
Automatic motivation	0,593	8.7471	<.001	
Step 6				0,567
Psychological capability	0.00797	0.0969	0.923	
Physical capability	0.16319	1.9543	0.052	
Physical opportunity	0.08745	1.5851	0.115	
Social opportunity	0.09470	1.3792	0.169	
Automatic motivation	0.42287	8.4502	< .001	
Reflective motivation	-0.02319	-0.3209	0.749	

Recycling behaviours of disposal

Frequency of disposal of waste

The mean general score for waste disposal was 3.66. Examining specific scores, the hierarchy in disposal frequency was observed as follows: Paper/cardboard disposal (3.93) had the highest score, followed by plastic disposal (3.84), glass disposal (3.84), metal disposal (3.61), and other waste disposal (3.07) (Table 2). This implies that paper/cardboard was the most frequently disposed recyclable, succeeded by plastic, glass, metal, and other waste.

Table 6

Descriptives of disposal behaviours frequency.

	Minimum	Maximum	Mean	SD	Skewness	Kurtosis	N
Plastic	1	6	3,84	1,61	-0,171	-1,15	195
Metal	1	6	3,61	1,67	0,0439	-1,27	195
Glass	1	6	3,84	1,72	-0,170	-1,29	195
Paper	1	6	3,93	1,61	-0,131	-1,23	195

Other waste	1	6	3,07	1,62	0,434	-0,937	195

Determinants of disposal behaviours

Reliability analysis for disposal determinants. Physical opportunity and Reflective motivation demonstrated very good internal consistency suggesting the items are highly reliable. Similarly, social opportunity showed good internal consistency. Indicating good reliability. psychological capability has an acceptable internal consistency. Lastly, automatic motivation displayed less favourable reliability questioning the reliability of this scale.

These internal consistency analyses provide evidence of the reliability of the grouped items within each category, ensuring that they reliably measure the respective COM-B determinants for disposal behaviours, with one exception.

Table 7
Reliability analysis - Cronbach's α for disposal determinants.

	Items	**Cronbach's α**
Psychological Capability	33, 34	0,750
Physical Capability	35	-
Physical Opportunity	36,37,38	0,907
Social Opportunity	39, 40, 41, 42	0,848
Automatic Motivation	43, 44	0,646
Reflexive Motivation	45, 46, 47, 48, 49	0,943

Table 8
Descriptives for disposal COM-B determinants.

	Min	Max	Mean	SD	Skewness	Kurtosis	N
Psychological Capability	1	7	5,65	1,28	-0,945	0,507	195
Physical capability	1	7	6,18	1,25	-1,77	3,18	195
Physical opportunity	1	7	5,08	1,64	-0,779	-0,105	195
Social opportunity	1	7	4,43	1,48	-0,147	-0,665	195
Automatic motivation	1	7	5,16	1,49	-0,538	-0,335	195
Reflective motivation	1	7	5,53	1,36	-0,908	0,409	195

Correlation analysis. Physical capability had a correlation coefficient of 0,390 indicating a weak correlation. Psychological capability, physical opportunity, social opportunity, and reflective motivation with respective correlation coefficients of 0.555, 0.558, 0.538 and 0.472, indicate a moderate correlation. Lastly, automatic motivation had a strong correlation coefficient of 0.647.

All the p-value for the correlation coefficients were found to be statistically significant ($p < 0.05$), indicating a low likelihood that the observed correlation occurred by random chance alone. (Appendix 2 - Table 12)

Regression analysis. Multicollinearity assumption check is essential to maintain the integrity of the regression model and to ensure that the estimated coefficients are reliable and interpretable. Upon analysis, the VIF values for disposal COM-B determinants were found to be less than 5, reassuring that multicollinearity is not a significant issue in this study. (Appendix 2 – Table 15)

From step 2 onwards, all the regression steps significatively increased the explained variance (R^2). (Appendix 2 – table 14) The final model, incorporating all six determinants, has an R-squared value of 0.486, $F(6, 188)=29,7$; $p<.001$. This indicates that approximately 48,6% of the variance in the disposal behaviour frequency can be explained by the combined influence of the COM-B determinants. Physical Capability shows significance with $p = 0.045$, with a standardized beta coefficient of 0.13336 suggesting a modest association with disposal behaviour frequency. Automatic Motivation stands out as highly significant with $p < 0.001$ and demonstrates a stronger association with a standardized beta coefficient of 0.655. There's a noteworthy result for Reflective Motivation with $p = 0.002$. Although statistically significant, it's important to mention that the beta coefficient is negative, indicating an inversed relationship with disposal behaviour frequency.

Table 9
Stepwise Regression Results for Predicting disposal behaviour frequency using COM-B Determinants.

Model	Standardized coefficient Beta	*t*	Sig. (*p*)	R^2
Step 1				0.308
Psychological capability	0.555	9.2581	<.001	
Step 2				0.315

Psychological capability	0.495	6.748	< .001	
Physical capability	0.103	1.404	0.162	
Step 3				0.370
Psychological capability	0.2905	3.369	< .001	
Physical capability	0.0688	0.970	0.333	
Physical opportunity	0.3267	4.111	< .001	
Step 4				0.405
Psychological capability	0.2672	3.17	0.002	
Physical capability	0.0786	1.14	0.258	
Physical opportunity	0.1483	1.57	0.118	
Social opportunity	0.2660	3.32	0.001	
Step 5				0.460
Psychological capability	0.0862	0.954	0.341	
Physical capability	0.0876	1.324	0.187	
Physical opportunity	0.1281	1.421	0.157	
Social opportunity	0.0813	0.932	0.352	
Automatic motivation	0.4067	4.415	< .001	
Step 6				0.486
Psychological capability	0.1116	1.257	0.210	
Physical capability	0.1338	2.015	0.045	
Physical opportunity	0.1002	1.130	0.260	
Social opportunity	0.0712	0.833	0.406	
Automatic motivation	0.6550	5.417	< .001	
Reflective motivation	-0.3092	-3.079	0.002	

Discussion

The first aim of this study was to assess the frequency of separation and disposal of different recyclable wastes. Our results indicated that within our population, the most separated waste categories are also what people dispose of the most, which is an intuitive conclusion. Most frequently recycled items were glass, paper, and plastic. The general recycling frequency scores for waste separation averaged 3.60, while for waste disposal, the average score was 3.66. These scores indicate that, on average, participants' recycling rates fall between 3 and 4 on the response scale. In practical terms, this corresponds to responses ranging from 'sometimes' to 'most of the time,' suggesting a moderate level of engagement in recycling behaviours among the participants.

The second aim of this study was to determine the associations between frequency of separation of waste and the respective determinants for separation. Similarly, for frequency of disposal of waste. Positive associations were found between all determinants and frequency of behaviour for both separation and disposal behaviours with differences in magnitude of these associations.

For separation, the behavioural determinants most strongly associated with the frequency of recycling behaviours were physical opportunity, social opportunity, and automatic motivation. These associations were notably strong, particularly in the case of automatic motivation that had the strongest correlation. On the other hand, psychological capability and physical capability exhibited comparatively weaker associations with the frequency of separation behaviors. Reflective motivation demonstrated a moderate association with the frequency of separation behaviors.

For disposal, the behavioural determinants most strongly associated with the frequency of disposal behaviours were psychological capability, physical opportunity, social opportunity, and automatic motivation. These associations were notably strong, particularly in the case of automatic motivation. Reflective motivation demonstrated a moderate association with behaviors related to disposal. Physical capability exhibited a weaker association with the frequency of disposal behaviors compared to the other factors.

Although correlational, the consistently strong connection between automatic motivation and both separation and disposal behaviors could imply a fundamental influence on recycling practices. These results could be pointing to the substantial role played by automatic

motivation in shaping individuals' recycling behaviors, suggesting that it could be an important catalyst in promoting recycling practices.

Lastly, the present study aimed to identify behavioural determinants, as outlined in the COM-B model, for both separation and disposal behaviours.

For separation, regression analysis revealed that automatic motivation significantly predicted separation behaviours with a robust association, aligning with previous research emphasizing the role of established recycling habits (Ouellette and Wood, 1998; Fan et al., 2019). Physical capability showed almost significant prediction of separation behaviours, indicating its potential relevance in influencing recycling habits. The considered model, with five determinants (psychological capability, physical capability, physical opportunity, social opportunity, and automatic motivation) explained approximately 56% of the variance in separation behaviours, indicating a substantial proportion of the variability in the observed outcomes is captured by the determinants. Interestingly, adding reflective motivation to the regression model did not alter the explained variance. This observation implies that in our sample, this determinant does not contribute additional explanatory power. It is possible that the information or variance brought by reflective motivation is already encompassed by the other determinants in the model. Hence, including reflective motivation doesn't provide new information beyond what is covered by the initial set of variables.

For disposal, physical capability significantly predicted disposal behaviours. This implies that being physically able to take the recyclable waste to the recycling facility predicts recycling behaviour. This finding is not surprising and was expected. Similar to separation, automatic motivation was a strong predictor of disposal behaviors frequency. Again, it is aligned with previous research emphasizing the role of established recycling habits (Ouellette and Wood, 1998; Fan et al., 2019). Automatic motivation for disposal also assessed intrinsic motivation as the inherent satisfaction and enjoyment for participating in the behavior, not just the habitual component. This scale had a questionable internal consistency. Therefore, while the scale significantly predicts disposal behavior, the questionable internal consistency suggests a need for cautious interpretation of the results. This calls for consideration of potential limitations in the reliability of the automatic motivation measurement for disposal behaviours, emphasizing the importance of further validation or refinement of the measurement tool for a more robust assessment.

Furthermore, Reflective motivation for disposal behaviours was found to unexpectedly have a negative predictive effect in the regression analysis. This negative association doesn't align with previous findings. Ölander and Thøgersen (1995) emphasized the role of motivation to protect the environment as an important factor influencing recycling behaviour, aligning with the reflective motivation component in the COM-B model. Moreover, Ramayah et al. (2012) suggests that a deep understanding of environmental issues leads to more positive attitudes toward recycling. Therefore, aligned with the Reflective Motivation component, authors suggest that environmental awareness and knowledge act as powerful motivators, influencing personal norms and attitudes. This poses as a contradiction with our findings.

The questions to assess disposal's reflective motivation, collectively aimed to assess individuals' perceptions and motivations regarding the proper disposal of recyclable waste. They explored responsible waste disposal behaviour, including the individual's sense of contributing to urban waste management and environmental preservation. Additionally, the questions gauged the perceived role modelling aspect, such as the responsibility to be positive examples for others. Furthermore, the assessment delved into the motivational factors, considering both external influences, such as observing others, and internal factors driven by the positive impact on society, future generations, and the environment. In essence, these questions aim to understand the psychological and motivational aspects influencing individuals' attitudes and behaviours toward the correct disposal of recyclable waste. Theoretical reasoning, as proposed by Hopper and Nielsen (1991) and Gilli et al. (2018) suggests that reflective motivation is expected to positively impact recycling behaviours. These studies highlight that the inclination to benefit others, an altruistic orientation, and the sense of contributing to the community are all positively linked to engaging in recycling behaviours. Therefore, this negative association in the regression model, warrants particular attention and further analysis to discern the underlying factors contributing to this unexpected result. This anomaly in the relationship between Reflective Motivation and disposal recycling frequency merits thorough exploration to enhance our understanding of the dynamics at play. Multicollinearity has been assessed and found to be within acceptable limits, and the reliability score for automatic motivation is deemed satisfactory at 0.943. This leads us to consider that the unusual result may be attributed to characteristics inherent in the study sample. This could be influenced by the homogeneity of the sample, where participants share similar traits, potentially constraining response variability and leading to unexpected results.

Implications of the Study

Portugal currently lacks an extensive body of research on recycling and its determinants. This study aims to contribute significantly to the existing knowledge by offering insights into various determinants influencing recycling behaviour. The design of this research is noteworthy, providing a broad perspective on the factors affecting recycling behaviour.

Given that our sample primarily comprises university students, future research could add to this study's findings by adopting a similar study design to assess an adult population. This approach would foster a richer understanding of recycling behaviour in Portugal, extending the generalizability of findings beyond the student demographic. Our study could be complementary to studies assessing recycling in adult population. But examining student's recycling behaviours is also important and interesting way for various reasons. Firstly, students are at a stage in life where habits are being formed and our study outlines the significance of habit on recycling behaviours. Investigating their recycling behaviors provides valuable insights into the factors that contribute to the development of sustainable practices, potentially influencing lifelong habits. Secondly, educational institutions play a significant role in shaping awareness and behavior. (Aleixo et al., 2021) Assessing students' recycling habits allows for a better understanding of the impact of educational initiatives on environmental consciousness and the adoption of sustainable actions. Moreover, students often reside in shared living environments, such as dormitories or shared housing. Studying their recycling habits unveils the influence of social factors and peer behavior on individual choices, offering insights into the dynamics of communal sustainability efforts. Considering that students are the future leaders, consumers, and decision-makers, understanding their recycling habits becomes crucial. It contributes insights into potential future trends in sustainable practices and the likelihood of environmentally conscious decision-making. Furthermore, identifying areas where students may fall short in their recycling habits presents valuable intervention opportunities. Targeted educational programs and initiatives can be implemented to foster a culture of environmental responsibility and sustainable living among students.

Public interventions aimed at promoting recycling should be guided by empirical data to enhance effectiveness and reproducibility. This study, by systematically examining various determinants of recycling behaviour, aimed to contribute with valuable insights to inform the design of interventions. Despite some limitations, there were interesting findings that could serve as a foundation for evidence-based strategies. It is important to ensure that public initiatives are not only well-informed but also more likely to be successful and replicable. This

approach aligns with the broader goal of fostering sustainable and impactful interventions in the realm of recycling behaviour.

For both separation and disposal behaviours, the common factor is automatic motivation. Within the Behaviour Change Wheel framework, various intervention types can target automatic motivation. (Michie et al, 2011) We can cite some examples: ***(i)***Education: Providing information to enhance knowledge and awareness, influencing automatic cognitive processes. ***(ii)*** Training: Enhancing skills and abilities related to the behaviour, facilitating automatic behavioural responses; ***(iii)***Environmental restructuring: Changing the physical or social context to make the desired behaviour more automatic or habitual; ***(iv)*** Modelling: Providing examples or role models to encourage imitation and the development of automatic behavioural patterns; ***(v)*** Enablement: Reducing barriers and providing resources to facilitate the automatic execution of the behaviour; ***(vi)*** Incentivization: Providing rewards or positive reinforcement to associate the behaviour with positive outcomes, reinforcing automatic motivation.

While further research is warranted to determine the most effective intervention functions, the choice should be guided by a nuanced understanding of the specific context, target audience, and the behaviour in focus. Combining multiple intervention functions is likely to be more effective in addressing complex behaviors.

Limitations

The present study is not without its limitations, and one key limitation to consider is the relatively small sample size in relation to the extensive length of our questionnaire. While our research aimed to explore a wide range of variables and gather in-depth data through a comprehensive questionnaire, the limited number of participants may have implications for the generalizability of our findings. It's important to acknowledge that with a larger sample size, we could have enhanced the statistical power of our analysis and potentially identified more nuanced relationships or effects that may have been obscured by the smaller sample. This limitation may have influenced the precision of the results and the strength of the conclusions. While our sample was carefully selected and met specific criteria, the findings should be interpreted within the context of this limitation. Future research in this area should aim to secure a larger and more diverse sample, which could provide a more robust foundation for drawing broader conclusions and generalizing our findings to a wider population.

This study relied on self-reported data obtained through a questionnaire, a common and practical approach in research. Although our study provided interesting results, it is important to acknowledge that self-report measures may introduce biases or inaccuracies in participants' responses. Future studies could enhance the robustness of findings by incorporating direct observations of recycling behaviours, providing a more objective understanding of participants' actions. This approach would offer valuable insights into actual recycling practices, complementing the self-reported data obtained in this study. Linder et al. (2021) reported findings suggesting that external factors (physical manipulations), such as the strategic placement of recycling bins and the use of prompts, emerged as more effective predictors of recycling behaviour compared to self-reported internal factors.

Despite the limitations of the small sample size, this study still provides valuable insights into the determinants influencing recycling behaviours. The study design and our results, though potentially constrained by the sample size, offer a foundation upon which future research can build. In addition, the thoroughness and comprehensiveness of our questionnaire design allowed for a detailed exploration of the variables under investigation, providing a strong basis for further inquiry.

Conclusion

In summary, for separation behaviours, our study underscores a strong association between separation behaviours and automatic motivation, emphasizing the influential role of habit formation in shaping separation frequency. Additionally, noteworthy connections were observed with physical opportunity, social opportunity, and reflective motivation. While causality cannot be definitively established from these relationships, interventions targeting the improvement of these determinants could hold promise for fostering positive outcomes in separation behaviours. Moreover, strategies aimed at enhancing automatic motivation could be instrumental in promoting separation behaviours.

As for disposal behaviours, automatic motivation is very strongly associated as well, while other determinants (i.e., psychological capability, physical and social opportunity, and reflective motivation), had a moderate association. Similarly, while definitive causality cannot be ascertained, the study underscores significant associations between determinants and recycling behaviours. The regression analysis confirmed the importance of automatic motivation in predicting disposal behaviours. This reiterates the pivotal impact of habit in shaping recycling behaviours. Particularly, the robust influence of automatic motivation on both separation and disposal behaviours is notable. (Ouellette and Wood, 1998)

Despite certain limitations, our study has uncovered interesting insights. Importantly, it enriches the limited understanding of recycling behaviours in the context of Portugal, shedding new light on this relatively unexplored area of research. Our study offers valuable insights that could steer future studies and inform the design of effective interventions aimed to increase relatively low recycling rates nationwide.

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Appendix

Appendix 1 – Questionnaire

Questionnaire developed and written in Portuguese:

1. Consentimento informado: Assinale aqui para confirmar que leu as informações sobre o estudo e autoriza a participação.
2. Queira por favor indicar a sua idade
3. Queira por favor indicar com que género se identifica
4. Por favor, indique o distrito em que reside atualmente ou onde passa a maior parte do tempo, (incluindo o período em que está deslocado para estudar, se for o caso)
5. Queira por favor indicar a sua área de estudo

SEPARATION – 21 Items

Frequência de comportamento de separação: *(total 6 itens)*

6. Separação dos resíduos orgânicos (e.g lixo de origem biológica, como alimentos e plantas) das restantes categorias de resíduos.
7. Separação das embalagens de plástico para reciclagem (e.g garrafas e garrafões de bebidas, sacos plásticos, copos para bebidas, embalagens, etc.)
8. Separação das embalagens de metal para reciclagem (e.g latas de bebidas e conservas, aerossóis, tabuleiros de alumínio, etc.)
9. Separação das embalagens de vidro para reciclagem (e.g garrafas de bebidas, boiões, frascos, etc.)
10. Separação de papel e cartão para reciclagem (e.g jornais, revistas, caixas de cartão, sacos de papel, etc.)
11. Separação outros resíduos (e.g Resíduos Elétricos e Eletrónicos, Lâmpadas, Pilhas, etc.)

COM-B separação: (*total 15 itens)*

a) Capacidade Psicológica:

12. Tenho o conhecimento suficiente para saber como separar corretamente os resíduos recicláveis.
13. Entendo os benefícios da separação correta dos resíduos recicláveis.
14. Confio na minha capacidade de separar corretamente os diferentes tipos de resíduos recicláveis;

b) Capacidade Física:

15. Tenho a capacidade física para separar corretamente os resíduos recicláveis.

c) Oportunidade Física:

16. Tenho espaço suficiente em casa para separar e armazenar os resíduos recicláveis.
17. Tenho os equipamentos necessários para separar e armazenar os resíduos recicláveis em casa.

d) Oportunidade Social:

19. Recebo apoio da minha comunidade para separar corretamente os resíduos recicláveis em casa.
20. Sinto-me pressionado(a) a separar o lixo para a reciclagem, porque é uma expectativa social que eu o faça.
21. Os meus amigos e familiares também separam os seus resíduos recicláveis.
22. A separação de resíduos recicláveis é valorizada pela minha comunidade.

e) Motivação Automática:

23. Separar os resíduos para a reciclagem é um hábito que já está enraizado na minha rotina.

f) Motivação Reflexiva:

24. Acredito que seja importante separar os resíduos recicláveis para a sociedade, para as gerações futuras, para o ambiente, etc.
25. Sinto que é importante ser um modelo positivo para os outros quando se trata da separação de resíduos recicláveis.
26. Sinto-me motivado(a) a separar os resíduos recicláveis quando penso no impacto positivo que esta prática tem para a sociedade, para as gerações futuras, para o ambiente, etc.
27. Sinto-me inspirado(a) a separar os resíduos recicláveis quando vejo que os outros também o fazem;

DISPOSAL - ***22 Itens***

Frequência comportamento de deposição: *(total 5 itens)*

28. Descarta embalagens de plástico nos equipamentos apropriados para a reciclagem (garrafas e garrafões de bebidas, sacos plásticos, copos para bebidas, embalagens, etc.)
29. Descarta embalagens de metal nos equipamentos apropriados para a reciclagem (latas, aerossóis, tabuleiros de alumínio, etc.)
30. Descarta embalagens de metal nos equipamentos apropriados para a reciclagem (latas, aerossóis, tabuleiros de alumínio, etc.)
31. Descarta papel e cartão nos equipamentos apropriados para a reciclagem (e.g jornais, revistas, caixas de cartão, sacos de papel, etc.)
32. Descarta outros resíduos (Resíduos Elétricos e Eletrónicos, Lâmpadas, Pilhas, etc.)

COM-B deposição: *(total 17 itens)*

a) Capacidade Psicológica:

33. Sei onde descartar os resíduos recicláveis;
34. Entendo os benefícios da recolha seletiva e do descarte correto de resíduos recicláveis.

b) Capacidade Física:

35. Tenho capacidade física para levar os resíduos recicláveis aos pontos de recolha seletiva.

c) Oportunidade Física:

36. Tenho acesso a equipamentos de recolha seletiva (e.g ecopontos, contentores de recolha porta-a-porta, máquinas de depósito e retorno, etc.) para efetuar a reciclagem na zona onde resido.
37. Os equipamentos de recolha seletiva aos quais tenho acesso, estão convenientemente localizados.
38. Os equipamentos de recolha seletiva aos quais tenho acesso, estão devidamente identificados e sinalizados.

d) Oportunidade Social:

39. Recebo apoio da minha comunidade para descartar corretamente os materiais recicláveis.
40. Descartar corretamente resíduos recicláveis é valorizado pela minha comunidade.
41. Sinto-me pressionado(a) descartar corretamente resíduos recicláveis, porque é uma expectativa social que eu o faça.
42. Os meus amigos e familiares também descartam os seus resíduos recicláveis, nos locais apropriados.

e) Motivação Automática:

43. Descartar corretamente resíduos recicláveis nos locais apropriados é um hábito que já está enraizado na minha rotina.
44. Sinto uma sensação positiva quando descarto corretamente resíduos recicláveis, nos locais apropriados.

f) Motivação Reflexiva:

45. Sinto que contribuo para a gestão de resíduos urbanos quando descarto corretamente resíduos recicláveis, nos locais apropriados.
46. Sinto que contribuo para a preservação do ambiente quando descarto corretamente os resíduos recicláveis.
47. Sinto que devo ser um modelo positivo para os outros, ao descartar corretamente resíduos recicláveis nos locais apropriados.
48. Sinto-me motivado(a) a descartar corretamente os resíduos recicláveis quando vejo que os outros também o fazem.
49. Sinto-me motivado(a) a descartar corretamente os resíduos recicláveis quando penso no impacto positivo que tem para a sociedade, as gerações futuras, o ambiente, etc.

Appendix 2 – Jamovi outputs

Sociodemographic Variables:

Table 1
Descriptives of sociodemographic variables

	idade	genero	distrito	area de estudo
N	177	195	195	187
Missing	18	0	0	8
Mean	24.1			
Median	22			
Standard deviation	7.23			
Minimum	17			
Maximum	70			

Table 2
Frequencies of age

idade	Counts	% of Total	Cumulative %
17	5	2.8 %	2.8 %
18	8	4.5 %	7.3 %
19	15	8.5 %	15.8 %
20	18	10.2 %	26.0 %
21	19	10.7 %	36.7 %
22	31	17.5 %	54.2 %
23	16	9.0 %	63.3 %
24	18	10.2 %	73.4 %
25	13	7.3 %	80.8 %
26	6	3.4 %	84.2 %
27	6	3.4 %	87.6 %
29	2	1.1 %	88.7 %
30	3	1.7 %	90.4 %
32	2	1.1 %	91.5 %
33	2	1.1 %	92.7 %
34	1	0.6 %	93.2 %
35	3	1.7 %	94.9 %
36	1	0.6 %	95.5 %
40	1	0.6 %	96.0 %
43	1	0.6 %	96.6 %
47	1	0.6 %	97.2 %
49	1	0.6 %	97.7 %
50	1	0.6 %	98.3 %
55	1	0.6 %	98.9 %
56	1	0.6 %	99.4 %

Table 2
Frequencies of age

idade	Counts	% of Total	Cumulative %
70	1	0.6 %	100.0 %

Table 3
Frequencies of gender

genero	Counts	% of Total	Cumulative %
Feminino	136	69.7 %	69.7 %
Masculino	49	25.1 %	94.9 %
Não binário	8	4.1 %	99.0 %
Outro	2	1.0 %	100.0 %

Table 4
Frequencies of districts

distrito	Counts	% of Total	Cumulative %
Aveiro	5	2.6 %	2.6 %
Braga	3	1.5 %	4.1 %
Bragança	1	0.5 %	4.6 %
Castelo Branco	2	1.0 %	5.6 %
Coimbra	14	7.2 %	12.8 %
Faro	8	4.1 %	16.9 %
Leiria	1	0.5 %	17.4 %
Lisboa	106	54.4 %	71.8 %
Portalegre	1	0.5 %	72.3 %
Porto	33	16.9 %	89.2 %
Setúbal	19	9.7 %	99.0 %
Vila Real	1	0.5 %	99.5 %
Viseu	1	0.5 %	100.0 %

Table 5
Frequencies of study area

area de estudo	Counts	% of Total	Cumulative %
Accounting	1	0.5 %	0.5 %
Arquitectura	1	0.5 %	1.1 %
Arquiteta	1	0.5 %	1.6 %
Arquiteto	1	0.5 %	2.1 %
Ciências Agrárias	2	1.1 %	3.2 %

Table 5
Frequencies of study area

area de estudo	Counts	% of Total	Cumulative %
Ciências Biológicas	16	8.6 %	11.8 %
Ciências Exatas e da Terra	9	4.8 %	16.6 %
Ciências Humanas	34	18.2 %	34.8 %
Ciências Sociais	33	17.6 %	52.4 %
Ciências da Saúde	17	9.1 %	61.5 %
Curso de especialização tecnológica	6	3.2 %	64.7 %
Design de interiores	1	0.5 %	65.2 %
Direito	3	1.6 %	66.8 %
Direito	3	1.6 %	68.4 %
Economia	1	0.5 %	69.0 %
Engenharias	29	15.5 %	84.5 %
Finanças	1	0.5 %	85.0 %
Gestão	1	0.5 %	85.6 %
Gestão	1	0.5 %	86.1 %
Gestão de marketing	1	0.5 %	86.6 %
Linguística, Letras e Artes	18	9.6 %	96.3 %
Línguas e relações empresariais	1	0.5 %	96.8 %
Marketing e Publicidade	1	0.5 %	97.3 %
Marketing e publicidade	1	0.5 %	97.9 %
Psicologia	1	0.5 %	98.4 %
aviação	1	0.5 %	98.9 %
economia	1	0.5 %	99.5 %
estudante	1	0.5 %	100.0 %

SEPARATION

Table 6

Descriptives of COM-B determinants for separation.

	CP sep	CF sep	OF sep	OS sep	MA sep	MR sep
N	195	195	195	195	195	195
Missing	0	0	0	0	0	0
Mean	5.58	6.48	4.48	4.20	4.45	5.60
Median	5.67	7	4.50	4.25	5	6.00
Standard deviation	1.11	0.954	1.72	1.35	1.98	1.31
Minimum	2.00	2	1.00	1.00	1	1.25
Maximum	7.00	7	7.00	7.00	7	7.00
Skewness	-0.664	-2.20	-0.277	0.0436	-0.430	-1.04

Descriptives of COM-B determinants for separation.

	CP sep	CF sep	OF sep	OS sep	MA sep	MR sep
Std. error skewness	0.174	0.174	0.174	0.174	0.174	0.174
Kurtosis	0.151	5.48	-0.814	-0.526	-1.00	0.857
Std. error kurtosis	0.346	0.346	0.346	0.346	0.346	0.346

Table 7
Correlation Matrix - score separation frequency and its corresponding determinants.

		score freq sep	CP sep	CF sep	OF sep	OS sep	MA sep	MR sep
score freq sep	Pearson's r	—						
	df	—						
	p-value	—						
CP sep	Pearson's r	0.379	—					
	df	193	—					
	p-value	< .001	—					
CF sep	Pearson's r	0.223	0.450	—				
	df	193	193	—				
	p-value	0.002	< .001	—				
OF sep	Pearson's r	0.565	0.430	0.265	—			
	df	193	193	193	—			
	p-value	< .001	< .001	< .001	—			
OS sep	Pearson's r	0.540	0.448	0.196	0.600	—		
	df	193	193	193	193	—		
	p-value	< .001	< .001	0.006	< .001	—		
MA sep	Pearson's r	0.730	0.414	0.120	0.631	0.614	—	
	df	193	193	193	193	193	—	
	p-value	< .001	< .001	0.094	< .001	< .001	—	
MR sep	Pearson's r	0.409	0.616	0.445	0.382	0.450	0.490	—
	df	193	193	193	193	193	193	—
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	—

Linear Regression Stepwise – Separation:

Table 8
Model Fit Measures

			Overall Model Test			
Model	**R**	**R^2**	**F**	**df1**	**df2**	**p**
1	0.379	0.144	32.4	1	193	< .001
2	0.384	0.147	16.6	2	192	< .001
3	0.585	0.343	33.2	3	191	< .001
4	0.625	0.391	30.5	4	190	< .001
5	0.753	0.567	49.4	5	189	< .001
6	0.753	0.567	41.0	6	188	< .001

Table 9
Model Comparisons

Comparison							
Model		**Model**	**ΔR^2**	**F**	**df1**	**df2**	**p**
1	-	2	0.00347	0.782	1	192	0.378
2	-	3	0.19537	56.757	1	191	< .001
3	-	4	0.04867	15.189	1	190	< .001
4	-	5	0.17543	76.513	1	189	< .001
5	-	6	2.37e-4	0.103	1	188	0.749

MODEL 1

Model Coefficients - score freq sep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.948	0.4746	2.00	0.047	
CP sep	0.474	0.0833	5.69	< .001	0.379

MODEL 2

Model Coefficients - score freq sep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.5303	0.6694	0.792	0.429	
CP sep	0.4371	0.0934	4.680	< .001	0.3494
CF sep	0.0965	0.1091	0.884	0.378	0.0660

MODEL 3

Model Coefficients - score freq sep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.4961	0.5893	0.842	0.401	
CP sep	0.1977	0.0882	2.243	0.026	0.1580
CF sep	0.0325	0.0964	0.336	0.737	0.0222
OF sep	0.3990	0.0530	7.534	< .001	0.4914

MODEL 4

Model Coefficients - score freq sep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.1495	0.5755	0.260	0.795	
CP sep	0.1061	0.0882	1.202	0.231	0.0848
CF sep	0.0546	0.0932	0.586	0.559	0.0373
OF sep	0.2819	0.0593	4.755	< .001	0.3471
OS sep	0.2949	0.0757	3.897	< .001	0.2863

MODEL 5

Model Coefficients - score freq sep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	-0.04600	0.4874	-0.0944	0.925	
CP sep	-0.00225	0.0757	-0.0297	0.976	-0.00180
CF sep	0.15539	0.0797	1.9497	0.053	0.10629
OF sep	0.08918	0.0548	1.6283	0.105	0.10984
OS sep	0.09227	0.0681	1.3553	0.177	0.08957
MA sep	0.41825	0.0478	8.7471	< .001	0.59353

MODEL 6

Model Coefficients - score freq sep

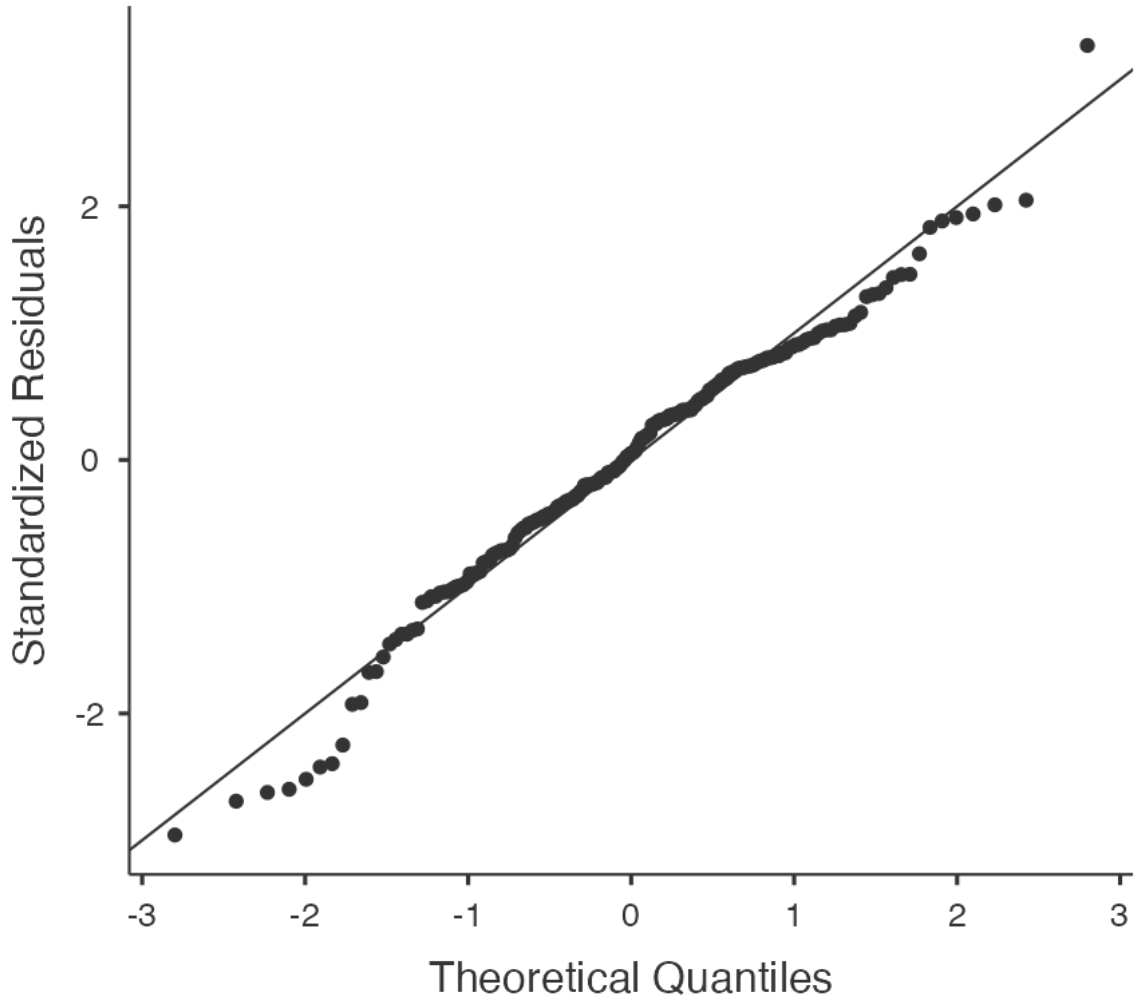
Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	-0.04662	0.4885	-0.0954	0.924	
CP sep	0.00797	0.0823	0.0969	0.923	0.00637
CF sep	0.16319	0.0835	1.9543	0.052	0.11163
OF sep	0.08745	0.0552	1.5851	0.115	0.10770
OS sep	0.09470	0.0687	1.3792	0.169	0.09193
MA sep	0.42287	0.0500	8.4502	< .001	0.60009
MR sep	-0.02319	0.0723	-0.3209	0.749	-0.02176

Assumption Checks:

Table 10
Collinearity Statistics

	VIF	Tolerance
CP sep	1.88	0.533
CF sep	1.42	0.706
OF sep	2.00	0.499
OS sep	1.93	0.519
MA sep	2.19	0.457
MR sep	2.00	0.501

Figure 1
Q-Q Plot of residuals – separation.



DISPOSAL

Table 11
Descriptives of COM-B determinants for disposal.

	CP dep	CF dep	OF dep	OS dep	MA dep	MR dep
N	195	195	195	195	195	195
Missing	0	0	0	0	0	0
Mean	5.65	6.18	5.08	4.43	5.16	5.53
Median	6.00	7	5.33	4.50	5.50	5.80
Standard deviation	1.28	1.25	1.64	1.48	1.49	1.36
Minimum	1.00	1	1.00	1.00	1.00	1.00
Maximum	7.00	7	7.00	7.00	7.00	7.00
Skewness	-0.945	-1.77	-0.779	-0.147	-0.538	-0.908
Std. error skewness	0.174	0.174	0.174	0.174	0.174	0.174
Kurtosis	0.507	3.18	-0.105	-0.665	-0.335	0.409
Std. error kurtosis	0.346	0.346	0.346	0.346	0.346	0.346

Table 12
Correlation Matrix – score disposal frequency and its corresponding determinants.

		score freq dep	CP dep	CF dep	OF dep	OS dep	MA dep	MR dep
score freq dep	Pearson's r	—						
	df	—						
	p-value	—						
CP dep	Pearson's r	0.555	—					
	df	193	—					
	p-value	< .001	—					
CF dep	Pearson's r	0.390	0.580	—				
	df	193	193	—				
	p-value	< .001	< .001	—				
OF dep	Pearson's r	0.558	0.686	0.467	—			
	df	193	193	193	—			
	p-value	< .001	< .001	< .001	—			
OS dep	Pearson's r	0.538	0.526	0.327	0.714	—		
	df	193	193	193	193	—		
	p-value	< .001	< .001	< .001	< .001	—		

Table 12
Correlation Matrix – score disposal frequency and its corresponding determinants.

		score freq dep	CP dep	CF dep	OF dep	OS dep	MA dep	MR dep
MA dep	Pearson's r	0.647	0.705	0.408	0.669	0.717	—	
	df	193	193	193	193	193	—	
	p-value	< .001	< .001	< .001	< .001	< .001	—	
MR dep	Pearson's r	0.472	0.656	0.472	0.550	0.570	0.838	—
	df	193	193	193	193	193	193	—
	p-value	< .001	< .001	< .001	< .001	< .001	< .001	—

Stepwise Linear Regression– disposal

Table 13
Model Fit Measures

			Overall Model Test			
Model	**R**	**R^2**	**F**	**df1**	**df2**	**p**
1	0.555	0.308	85.7	1	193	< .001
2	0.561	0.315	44.1	2	192	< .001
3	0.609	0.370	37.4	3	191	< .001
4	0.636	0.405	32.3	4	190	< .001
5	0.679	0.460	32.3	5	189	< .001
6	0.697	0.486	29.7	6	188	< .001

Table 14
Model Comparisons

Comparison							
Model		**Model**	**ΔR^2**	**F**	**df1**	**df2**	**p**
1	-	2	0.00704	1.97	1	192	0.162
2	-	3	0.05573	16.90	1	191	< .001
3	-	4	0.03448	11.01	1	190	0.001
4	-	5	0.05565	19.49	1	189	< .001
5	-	6	0.02590	9.48	1	188	0.002

MODEL 1

Model Coefficients - score freq dep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	0.0236	0.4025	0.0587	0.953	
CP dep	0.6432	0.0695	9.2581	< .001	0.555

MODEL 2

Model Coefficients - score freq dep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	-0.341	0.4780	-0.713	0.477	
CP dep	0.574	0.0851	6.748	< .001	0.495
CF dep	0.122	0.0871	1.404	0.162	0.103

MODEL 3

Model Coefficients - score freq dep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	-0.2494	0.4599	-0.542	0.588	
CP dep	0.3370	0.1000	3.369	< .001	0.2905
CF dep	0.0817	0.0843	0.970	0.333	0.0688
OF dep	0.2951	0.0718	4.111	< .001	0.3267

MODEL 4

Model Coefficients - score freq dep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	-0.5330	0.4564	-1.17	0.244	
CP dep	0.3099	0.0978	3.17	0.002	0.2672
CF dep	0.0933	0.0822	1.14	0.258	0.0786
OF dep	0.1339	0.0852	1.57	0.118	0.1483
OS dep	0.2671	0.0805	3.32	0.001	0.2660

MODEL 5

Model Coefficients - score freq dep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	-0.5943	0.4359	-1.364	0.174	
CP dep	0.1000	0.1048	0.954	0.341	0.0862

MODEL 5

Model Coefficients - score freq dep

Predictor	Estimate	SE	t	p	Stand. Estimate
CF dep	0.1040	0.0785	1.324	0.187	0.0876
OF dep	0.1157	0.0814	1.421	0.157	0.1281
OS dep	0.0817	0.0876	0.932	0.352	0.0813
MA dep	0.4061	0.0920	4.415	< .001	0.4067

MODEL 6

Model Coefficients - score freq dep

Predictor	Estimate	SE	t	p	Stand. Estimate
Intercept	-0.3350	0.4346	-0.771	0.442	
CP dep	0.1294	0.1030	1.257	0.210	0.1116
CF dep	0.1589	0.0789	2.015	0.045	0.1338
OF dep	0.0905	0.0801	1.130	0.260	0.1002
OS dep	0.0715	0.0858	0.833	0.406	0.0712
MA dep	0.6539	0.1207	5.417	< .001	0.6550
MR dep	-0.3384	0.1099	-3.079	0.002	-0.3092

Assumption Checks

Table 15

Collinearity Statistics

	VIF	Tolerance
CP dep	2.88	0.347
CF dep	1.61	0.619
OF dep	2.88	0.348
OS dep	2.67	0.375
MA dep	5.35	0.187
MR dep	3.69	0.271

Figure 2
Q-Q Plot of residuals – disposal.

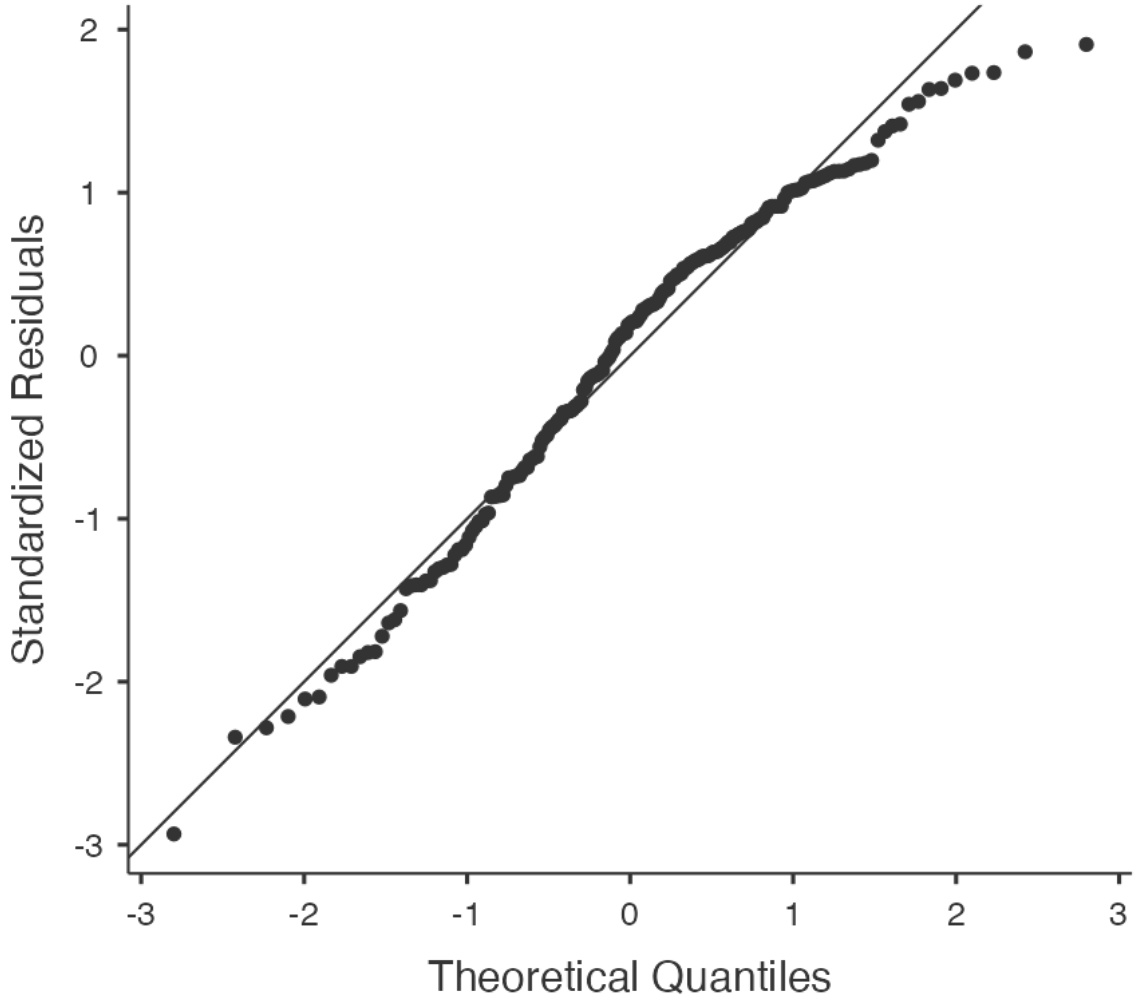


Table 16
Descriptives for separation behaviour (score freq sep) and disposal behaviour (score freq dep)

	score freq sep	score freq dep
N	195	195
Missing	0	0
Mean	3.60	3.66
Median	3.67	3.60
Standard deviation	1.40	1.48
Minimum	1.00	1.00
Maximum	6.00	6.00
Skewness	-0.0496	-0.0197
Std. error skewness	0.174	0.174
Kurtosis	-1.13	-1.16
Std. error kurtosis	0.346	0.346

Reliability Analysis – it12, 13, 14

Table 17
Scale Reliability Statistics – psychological capability

	Cronbach's α
scale	0.830

Reliability Analysis – it16,17

Table 18
Scale Reliability Statistics – physical opportunity

	Cronbach's α
scale	0.836

Reliability Analysis – it19, 20, 21, 22

Table 19
Scale Reliability Statistics – social opportunity

	Cronbach's α
scale	0.769

Reliability Analysis – it24, 26, 27

Table 20
Scale Reliability Statistics – reflective motivation

	Cronbach's α
scale	0.896

Reliability Analysis – it33, 34

Table 21
Scale Reliability Statistics – psychological capability

	Cronbach's α
scale	0.750

Reliability Analysis – it36, 37, 38

Table 22
Scale Reliability Statistics – physical opportunity

	Cronbach's α
scale	0.907

Reliability Analysis – it39, 40, 41, 42

Table 23
Scale Reliability Statistics – social opportunity

	Cronbach's α
scale	0.848

Reliability Analysis – it43, 44

Table 24
Scale Reliability Statistics – automatic motivation

	Cronbach's α
scale	0.646

Reliability Analysis – it45, 46, 47, 48, 49

Table 25
Scale Reliability Statistics – reflective motivation

	Cronbach's α
scale	0.943