Resources, Conservation & Recycling Advances 18 (2023) 200148

Contents lists available at ScienceDirect

Resources, Conservation & Recycling Advances

journal homepage: www.sciencedirect.com/journal/Resources-Conservation-and-Recycling-Advances

Identifying the determinants of face mask disposal behavior and policy implications: An application of the extended theory of planned behavior

Oluseye O. Oludoye [a,#,*], Stephan Van den Broucke [b], Xi Chen [c], Nuta Supakata [d], Lanrewaju A. Ogunyebi [e], Kelechi L. Njoku [e]

[a] Center of Excellence in Hazardous Substance and Environmental Management, Chulalongkorn University, Bangkok, 10330, Thailand
[b] Psychological Sciences Research Institute, Université catholique de Louvain, Louvain-la-Neuve, Belgium
[c] The JC School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong, China
[d] Department of Environmental Science, Faculty of Science, Chulalongkorn University, Bangkok, Thailand
[e] Environmental Biology Research Unit, Cell Biology and Genetics Department, University of Lagos, Akoka, Lagos, Nigeria

ARTICLE INFO

Keywords:
COVID-19
Disposal behavior
Waste management
Nigeria

ABSTRACT

A study in Nigeria examined the psychological factors affecting face mask disposal behavior (DB) during the COVID-19 pandemic. The Theory of Planned Behavior (TPB) was used, with awareness of consequences and institutional barriers added. 1183 respondents completed an online survey, and structural equation modeling was used to analyze the data. The original TPB model revealed that attitudes, perceived behavioral control, and subjective norms explained 65% of the variance in respondents' behavior. Behavioral intention and perceived behavioral control accounted for 59.3% of the variance in DB. The extended TPB model, which included awareness of consequences and perceived institutional barriers, improved the model's explanatory power by 12.8%. Both TPB models adequately predicted face mask (FM) disposal behavior, with implications for policy-makers and waste management authorities to design interventions to promote proper FM disposal behavior.

1. Introduction

In recent years, plastic pollution has emerged as a global environmental crisis. This crisis was primarily due to improper post-consumption disposal of plastic waste (Sarkar et al., 2022). As a result, massive amounts of plastic waste leak into terrestrial and aquatic environments. Microplastics are formed due to the wear and tear and degradation of plastic litter, and it is gaining popularity due to the adverse effects on wildlife and human health (Mghili et al., 2022). Furthermore, various disasters may unintentionally contribute to microplastic contamination due to improper management and treatment of plastics after use.

The outbreak of the Coronavirus Disease 2019 (COVID-19) pandemic, a global disaster, prompted governments across the world to implement stringent control measures such as social distancing, contact tracing, confinement and wearing face masks (FM), covering the nose and mouth (Wang et al., 2020; World Health Organization (WHO), 2022). With the pandemic continuing in many parts of the world and new strains of COVID-19 appearing, the demand for FM has exploded and is expected to increase further (University of Oxford, 2023). It has been reported that the outbreak of the highly infectious omicron variant increased the demand for FM among Americans (Goldberg and Court, 2021; Hufford, 2022). To this day, there is no cure for the novel coronavirus problem (Hou et al., 2022). Even after vaccination, most nations still require wearing face masks as of December 2022 (University of Oxford, 2023). Available vaccines cannot wholly prevent infection due to insufficient vaccination coverage in many countries to achieve pandemic control (Brüssow and Zuber, 2022; Irfan et al., 2021). As a result, masks could become an essential part of people's daily lives in the coming years. As such, the global market for FM is projected to increase by 4% by 2026 (ReportLinker, 2021). However, since FM have a limited usage time and must be replaced every 4 to 10 h to secure adequate protection against the virus, increased usage also implies increased numbers of disposed FM.

Improper disposal of FM poses a risk of viral transmission to others and creates environmental waste (Fadare and Okoffo, 2020). FM contain material such as plastics that are not biodegradable, and used masks are often improperly discarded, ending up in places such as bodies of water,

* Corresponding author.
E-mail address: soludoye@yahoo.com (O.O. Oludoye).
Author is now at the Department of Environmental Science, Faculty of Science, Chulalongkorn University, Bangkok, Thailand

https://doi.org/10.1016/j.rcradv.2023.200148

Available online 16 April 2023

public roads, parks, or highways. Recent studies from Morocco (Mghili et al., 2022), Thailand (Tesfaldet et al., 2022), Ghana (Amuah et al., 2022), Ireland (Rowan and Laffey, 2021), India (Parashar and Hait, 2021) and the Philippines (Limon et al., 2022) show that these practices are prevalent and pose significant environmental challenges (Fadare and Okoffo, 2020). Unsafe disposal of FM waste causes soil and groundwater pollution and harms biota. More importantly, this plastic waste contains toxic chemicals such as phthalate additives and absorbs contaminants from surrounding environments, potentially harming wildlife, the human food chain, and humans (Tesfaldet et al., 2022).

The volume of mask waste generated worldwide daily is incalculable as most countries still use FM (Wang et al., 2022). However, the massive global consumption of FM has resulted in an emerging environmental issue due to improper disposal of used face masks. Because of differences in waste management practices, many countries face a higher risk of contamination from improper FM disposal, especially in developing countries (Tripathi et al., 2020). In most countries, the wastes are mainly disposed of in hazardous landfills and dumping grounds which has the potential to spread the virus and pollute the aquatic ecosystem (Tripathi et al., 2020; Wang et al., 2022). As a result, improper disposal of used FM has emerged as a global concern (Wang et al., 2022).

The situation in Nigeria is no different, and microplastics are becoming increasingly popular due to their adverse effects on wildlife and human health (Babatola et al., 2023). After use, improper management and treatment of plastic waste also contribute to microplastic contamination. The COVID-19 pandemic has further exacerbated the plastic pollution problem in the country due to the increased demand and usage of face masks, which are often improperly disposed of after use (Olewu, 2020). In Nigeria, as in many other countries, the improper disposal of used face masks poses a risk of viral transmission to others and creates environmental waste. Used masks are often improperly discarded, ending up in places such as bodies of water, public roads, parks, or highways, posing significant environmental challenges **(Appendix A)**. In Nigeria, the waste generated from the massive global consumption of face masks is often disposed of in hazardous landfills and dumping grounds, which has the potential to spread the virus and pollute the aquatic ecosystem (Fadare and Okoffo, 2020).

Recent studies have shown that the COVID-19 pandemic has exacerbated the plastic pollution problem due to the increased demand and usage of face masks, which are often improperly disposed of after use. However, addressing this issue requires a multifaceted approach that includes behavior change and policy interventions. Such efforts can help to mitigate the adverse impacts of the COVID-19 pandemic on the environment and protect public health. Ultimately, it is crucial to recognize that the pandemic has highlighted the need for sustainable and resilient solutions that can address both public health and environmental challenges. This study's contribution to the environment, climate change impact, and sustainability lies in its potential to inform effective interventions that promote responsible waste management practices, reduce the environmental impact of face masks, and support sustainable waste management practices in the face of the COVID-19 pandemic.

Behavior change study has proven helpful in understanding why people act in ways detrimental to their health and the environment. Understanding human behavior as a driving force behind anthropogenic issues (in this case, FM disposal) is critical in this context (Zebardast and Radaei, 2022). Encouraging individuals to safely dispose of used FM is critical for combating the spread of COVID-19 and reducing environmental pollution. To that effect, it is necessary to investigate the used FM discarding behavior and understand its underlying factors better. Identifying the cognitive determinants of FM disposal can provide guidelines and pointers to formulate more effective prevention policies that account for people's behaviors. Used FM disposal behavior (DB) is defined as an individual's actions and practices to dispose of used FM in a safe and environmentally friendly manner. The DB involves incineration, wrapping FM with plastic bags, sorting them from other wastes, and disposal of used FM in closed bins (Limon et al., 2022). The behavioral tendency of an individual to safely dispose of used masks is referred to as the behavioral intention (BI) towards safe disposal.

According to the TPB, beliefs (attitudes, norms and perceived behavioral control) and intentions may influence FM disposal behavior. However, from a global view, there is no integrated evidence on the abovementioned variables towards FM disposal during pandemics, including COVID-19. Inclusion of these variables could support the relevant stakeholders in making evidence-based recommendations on the proper disposal of used FM, which is vital to maintaining environmental quality. The beliefs, intentions, and practices towards used FM disposal in the general population are crucial for adherence to safe FM disposal during pandemics or epidemics. Most importantly, this information is expected to raise public awareness of the importance of reducing plastic pollution through individual behavior change.

While previous studies have investigated COVID-19 face mask environmental impact in various countries, and the Theory of Planned Behavior (TPB) has been frequently utilized in pro-environmental behavior research, a gap in the literature exists concerning the psychological determinants of face mask disposal. Despite recommendations by Amuah et al. (2022) to explore FM disposal determinants, little empirical research has been conducted on this topic. Therefore, it is crucial to investigate the factors that affect people's disposal behavior regarding used face masks. By doing so, it would be possible to understand better the underlying psychological mechanisms that influence this behavior and develop targeted interventions that address these determinants to improve mask disposal practices. This study aims to fill this gap by identifying and examining the psychological factors influencing face mask disposal behavior among different populations.

The significance of the study is that it would contribute to filling a critical gap in the COVID-19 literature. Understanding the psychological determinants of face mask disposal behavior is essential to developing effective interventions that promote responsible waste management practices, protect public health, and reduce the environmental impact of COVID-19 face masks. The study's findings could inform policymakers, health officials, and waste management professionals about the factors that influence face mask disposal behavior, thereby enabling them to design evidence-based interventions that target these determinants. The study's results may also help individuals understand the importance of proper face mask disposal and encourage them to adopt appropriate waste management practices, thus contributing to a cleaner environment and healthier communities.

Thus, the current study aimed to i) identify the cognitive factors influencing used FM disposal behavior during the COVID-19 pandemic and ii) provide policy implications for relevant stakeholders in the environmental health sectors. To identify the psychological determinants of DB and BI, we applied an extended version of the Theory of Planned Behavior (TPB) as a theoretical framework presenting the psychosocial variables likely to influence FM disposal behavior. We tested the explanatory power of both the original and extended TPB models (Fig. 1).

2. Theoretical framework

2.1. The theory of planned behavior

The TPB is a social psychological model introduced by Ajzen (1991) to explain intentional behavior. Its central tenet is that a person's intention to perform a given behavior is based on three factors: attitudes, subjective norms and perceived behavioral control (Abadi et al., 2021; Ajzen, 2020). Since its inception, the TPB has been widely deployed to explain various behaviors. Empirical evidence has also been provided for its utility in explaining adherence to preventive behavior against COVID-19 (Prasetyo et al., 2020; Sturman et al., 2021; Trifiletti et al., 2022) and pro-environmental behavior.

According to the TPB, the most direct predictor of an individual's

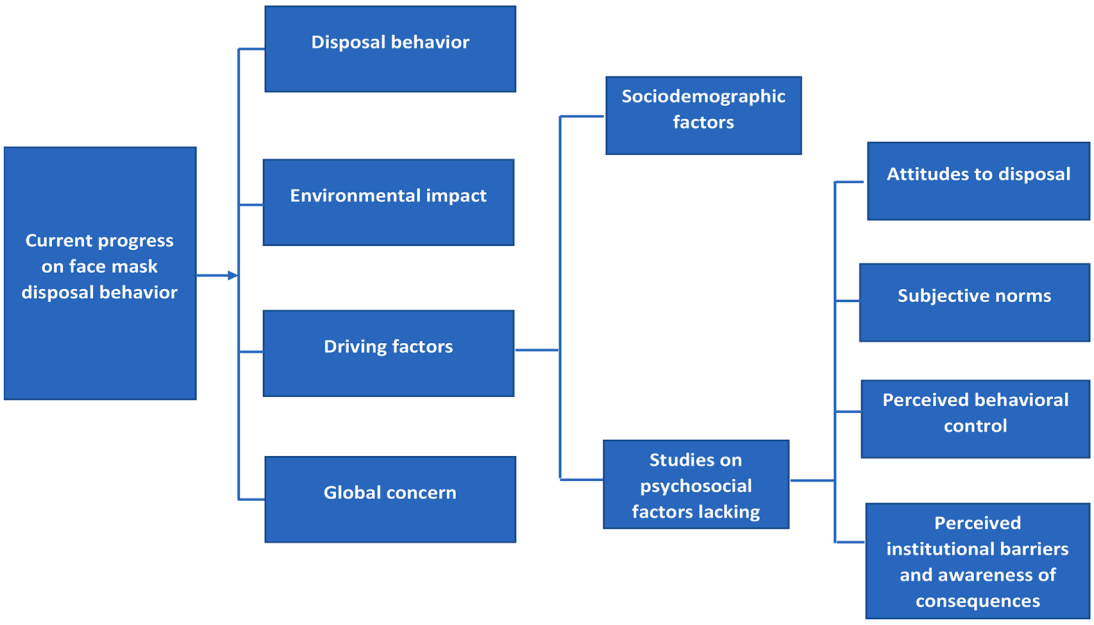

Fig. 1. The SmartArt of the literature review.

behavior is **behavioral intention** (BI) (Khan et al., 2020). Behavioral intentions are defined as the perceived likelihood of a person to implement a behavior. Numerous studies have confirmed that behavioral intention positively predicts actual behavior (Ao et al., 2022; Shi et al., 2021). In the current study, it would be assumed that BI would predict peoples' safe disposal of used FM.

H1. : There is a positive relationship between people's BI and actual behavior towards the safe disposal of used face masks.

According to the TPB, the first determinant of an individual's intention to perform a specific behavior is their **attitude** (ATT) towards that behavior. In a specific situation, an attitude indicates the positive or negative evaluation of the behavior (Nketiah et al., 2022). Thus, people with a negative attitude towards a particular behavior are less likely to perform it and vice versa (Khan et al., 2020). Attitudes comprise two different but highly interrelated entities: emotional and cognitive (De Bruijn, 2010). The emotional component is one's feelings concerning a subject, while the cognitive part concerns individual beliefs. Attitude has been shown to be a highly reliable predictor of behaviors and intentions to act (Cudjoe et al., 2022). Also, the relationship between people's attitudes and intentions has been reported for many pro-environmental behaviors, including waste recycling, waste sorting, technology adoption and sustainable mining (Adu-Gyamfi et al., 2022; Cudjoe et al., 2022; Nketiah et al., 2022; Obuobi et al., 2022; Shi et al., 2021; Soomro et al., 2022).

H2. : There is a positive relationship between people's attitudes and behavioral intentions toward the safe disposal of used face masks.

Subjective norms (SN) constitute the second factor influencing people's intentions, in the sense that the intention to perform a specific behavior is impacted by the perceived approval of that behavior by others (Ajzen, 2020). Subjective norms are based on the observations of others in one's life (Goh et al., 2017) and on the belief whether or not (significant) others approve of the behavior (Soomro et al., 2022). Subjective norms have been shown to play a significant role in determining behavior in the existing literature, and subjective norms have been proposed as a potential predictor of intent. Some of the studies are battery-swap technology adoption (Adu-Gyamfi et al., 2022), sustainable mining (Obuobi et al., 2022), electric vehicles (Adu-Gyamfi et al., 2022) and waste sorting (Cudjoe et al., 2022). Based on the literature above, this study proposes the following hypotheses.

H3. : There is a positive relationship between people's subjective norms and behavioral intentions towards the safe disposal of their used face masks.

A third factor affecting individuals' behavioral intentions is **perceived behavioral control** (PBC). This concept refers to the person's perception of the comfort or difficulty of performing the behavior (Savari and Gharechaee, 2020). Several studies have shown that PBC positively shapes behavioral intention and actual behaviors in waste management (Coşkun and Özbük, 2020), sustainable mining practices (Obuobi et al., 2022), composting (Rastegari Kopaei et al., 2021), recycling (Soomro et al., 2022) and battery-swap technology adoption (Adu-Gyamfi et al., 2022). It implies that people would be more likely safely dispose of their used FM if they see it as an easy behavior.

H4. : There is a positive relationship between people PBC and BI towards the disposal of their used face masks.

H5. : There is a positive relationship between people's PBC and actual behavior towards the disposal of their used face masks.

2.2. *Extension of the TPB*

Although the predictive validity of the TPB has been confirmed by a large body of literature, including several meta-analyses, however, the model has been criticized for its parsimony (Ajzen, 2015). Consequently, various attempts have been made to extend the TPB, particularly in adopting pro-environmental behavior. Ajzen (2020) states that new components could be added to the model for improvement. Hence, numerous researchers have incorporated other variables not originally in the model and confirmed that it improves the explanatory power (Yuriev et al., 2020). Amongst such factors that have been found to influence pro-environmental behaviors but which are not part of the original TPB are awareness of consequence (AC) and perceived institutional barriers (PIB) (Arkorful et al., 2021; Khan et al., 2020), both of which are important (respectively internal and external) factors influencing human decision-making abilities.

Awareness of consequence (AC) constitutes a vital variable in the Norm Activation Model (NAM) (Park and Ha, 2014). It refers to the individual's alertness for possible adverse outcomes of *not* performing a

specific behavior. Research has shown a significant relationship between AC and ATT, BI and actual behaviors (Arkorful et al., 2021; Fang et al., 2021; Meng and Han, 2018; Nketiah et al., 2022; Shi et al., 2021). Specifically, AC directly impacts ATT and indirectly positively affects BI via ATT (Arkorful et al., 2021; Meng and Han, 2018). Thus, a greater degree of AC leads to a more positive ATT towards pro-environmental behaviors, which in turn influences BI (Arkorful et al., 2021). Overall, a high AC with respect to a worthwhile behavior (i.e., safe disposal of used face masks) may trigger one's appreciation for and adoption of pro-environmental behavior. Given the above relationships, the following hypotheses are suggested.

H6. : There is a positive relationship between AC and ATT towards the disposal of used face masks.

H7. : There is a positive relation between AC and BI towards the disposal of used face masks.

H8. : There is a positive relationship between AC and actual DB of used face masks.

Another factor influencing pro-environmental behavior is **perceived institutional barriers** (PIB). This notion refers to factors that inhibit people from carrying out practices for their benefit (Khan et al., 2020). Since behavioral change not only depends on an individual's choice but the institutional context must also be considered to explain the adoption of pro-environmental or infection control practices (Li et al., 2021). For instance, Khan et al. (2020) reported that accessibility to recycling facilities positively influences recycling behavior. Previous research on pro-environmental behaviors has also shown that institutional factors such as governmental or non-governmental policies influence people's behaviors (Lee and Li, 2021).

Regarding FM disposal, PIB can involve a lack of facilities, relevant resources or information affecting safe disposal. Thus, we may presume that people perceiving more institutional barriers would be less likely to safely dispose of their used face masks. As Takács-Sánta (2007) posit that situational factors such as PIB could inhibit one's controllability (PBC) and environmental concern (AC) regarding a behavior (Nketiah et al., 2022), we also propose that people who perceive higher PIB would be less likely to perceive control over their FM disposal behavior and less aware of the consequences. A previous study noted that environmental concerns positively influence waste recycling behavior from residents of Jiangsu in China (Nketiah et al., 2022). Thus, we proposed the following hypotheses.

H9. : There is a negative relationship between PIB and actual DB of used face masks.

H10. : There is a negative relationship between PIB and AC regarding used face masks.

The current study intended to explore to what extent the original TPB and the extended version with AC and PIB added explain FM disposal behavior. Based on an in-depth review of the extant literature of pro-environmental behavior studies, AC and PIB have rarely been added to extend and explore the TPB (Yuriev et al., 2020).

3. Methodology

3.1. Study area

The Federal Republic of Nigeria is a West African country with a diverse population of approximately 219 million inhabitants living in an area of 923,768 km sq (356 669 sq mi) (Idowu, 2013). Nigeria shares land borders with Benin (773 km) to the west, Chad (87 km) and Cameroon (1690 km) to the east, and Niger (1497 km) to the north. The country has a coastline of about 853 km, which lies on the Gulf of Guinea on the Atlantic Ocean (Idowu, 2013). Nigeria is facing the challenge of proper disposal of used face masks, which is contributing to plastic pollution in the country. Face mask usage has increased due to the COVID-19 pandemic, including in Nigeria, to stop the virus from spreading. However, improper face mask disposal has become a significant issue in the nation, causing plastic pollution and environmental deterioration (Idowu et al., 2023). Recent data indicates that Nigeria produces 32 million tons of waste annually, with plastic waste accounting for a sizable portion (> 30%) of the total (Nwafor and Walker, 2020). As a result of the COVID-19 pandemic and the widespread use of face masks, there is growing concern about the environmental effects of mask waste (Olewu, 2020). In Nigeria, wearing a face mask is required in public spaces to stop COVID-19 from spreading. Despite this policy, regional variations exist in how often people wear face masks. Some have higher compliance rates than other areas and cities (Akinsehinwa et al., 2022). Several factors, such as the accessibility and availability of face masks, the level of education and awareness regarding the value of face masks, and cultural beliefs and practices, impact the level of mask-wearing adherence (Ebekozien et al., 2022; Yang et al., 2022).

The Nigerian waste management system significantly impacts the issues surrounding face mask disposal. Significant issues with Nigeria's waste management system include a lack of public awareness of waste management, inadequate infrastructure, and poor waste collection and disposal procedures (Nwafor and Walker, 2020). Therefore, face masks and other waste are frequently disposed of improperly. A recent study by the Environmental Rights Action/Friends of the Earth Nigeria (ERA/-FoEN) (ERA/FoEN, 2021) estimates that during the first year of the pandemic, Nigerians used 1.5 billion disposable face masks. These non-biodegradable masks are a threat to the environment and public health because they add to plastic waste. Used face masks are frequently disposed of improperly as litter and in water bodies, endangering wildlife and people through environmental pollution (Appendix A).

3.2. Sampling and data collection

This was a cross-sectional study involving an online questionnaire administration for data collection via the application of Google Forms. To allow for the collection of representative data and maximum participation of online users and provide enough time for participation, data gathering took place from November 2020 to October 2021. Participation in the study was voluntary, and participants could opt-out at any stage. To be included in the study, participants had to: i) understand the English language; ii) be older than 18 years; iii) be a Nigerian citizen or permanent resident; iv) use at least three face masks per week. Of the 1351 participants that finished the online survey, only 1183 met the inclusion criteria; the remaining 168 were eliminated.

3.3. Measurement

The online survey questionnaire was divided into three major sections. The first section contained the informed consent form for the participants to agree on before proceeding. The second part involved questions regarding the participants' demographic situation and face mask types. The third part concerned the participants' disposal behaviors and questions to measure original and extended TPB constructs. Five items measured ATT, BI and PIB. Three items measured SN and AC, while seven and four items, respectively, measured DB and PBC. Five-point Likert's scale was used to assess the agreement or disagreement on the subject matter (1 = strongly disagree to 5 = strongly agree). BI and DB were measured with a Likert scale ranging from always (5) to never (1) (intended to) dispose of FM respectfully. The instrument was developed based on recently published articles on used FM disposal practices (Table 1). A panel of environmental science, environmental psychology, and public health experts reviewed a draft version of the questionnaire for content validity. Modifications were made based on their comments before it was used for data collection. A pilot study was conducted in a small sample of participants (n = 50) to assess the

Table 1
Instrument measurement.

Variables	Measurement	Sources
Disposal behaviours (DB)	I dumped used face masks anywhere, such as at homes, in handbags, pockets, workplaces, walkways or streets ® I used recycle bin to dispose of face masks I sorted used face masks from other wastes before disposal I buried used face masks at a depth of at least ten feet from the surface to prevent infection I disposed of used masks by wrapping them with plastic bags before dumping them in waste bins I disposed of used face masks immediately upon removal in closed bins. I burned face masks after use to avoid infection	(Olewu, 2020), (Tesfaldet et al., 2022), (Limon et al., 2022)
Behavioral intentions (BI)	I intend to dispose of my face masks immediately it tears I am willing to use non-disposable or reusable face masks to reduce wastes I intend to dispose of my face masks as soon as it falls on the floor I decided to wash used face masks before disposal I plan to cut used face masks into small parts to prevent re-using them	(Limon et al., 2022), (Li et al., 2021), (Olewu, 2020)
Attitude (ATT)	I think I would be less vulnerable to COVID-19 infection If I adopted safe disposal measures I think adopting appropriate disposal techniques will inconvenient me ® I feel insecure if someone dumps used facemasks in public during the COVID-19 outbreak. I think disposing of used face masks with regular waste is improper I do not think mismanagement of used face masks could expose me to COVID-19 infection ®	(Li et al., 2021), (Prasetyo et al., 2020), (Lee and Li, 2021), (Roy et al., 2020)
Perceived behavioral control (PBC)	I am confident that I can prevent getting infected by COVID-19 if I safely dispose of my face masks Proper disposal of face masks is entirely within my ability or control. I think safe disposal protocols are easy to be implemented I am confident that I have enough knowledge of appropriate disposal techniques for face masks	(Prasetyo et al., 2020), (Lee and Li, 2021), (Sen-Crowe et al., 2020), (Oyeniran and Chia, 2020)
Subjective norms (SN)	Most people who are important to me are disposing of face masks with caution to limit the spread of COVID-19 Most people whose opinion matter to me are littering the streets, walkways, or workplaces ® Most people who influence my life are following the COVID-19 preventive disposal protocols given by the government.	(Prasetyo et al., 2020), (Li et al., 2021)
Perceived institutional barriers (PIB)	The government does not emphasize the health and environmental detriments of improper disposal of face masks in their information dissemination. Lack of functional designated trash bins for hazardous waste disposal. Face mask manufacturers do not provide me with information on product disposal guidelines. Healthcare centers or other organizations do not provide adequate face mask disposal and management on their premises to avoid public littering. Face mask vendors do not educate me directly or use posters on properly disposing of used facial masks.	(Khan et al., 2020), (Olewu, 2020)
Awareness of consequence (AC)	I am aware that I am liable for contracting COVID-19 due to the wrong disposal of used face masks I am aware that used face masks could cause marine litter or harm aquatic life I am aware that I could endanger the life of others due to improper disposal behaviours of used face masks	(Meng and Han, 2018), (Shi et al., 2021), (Arkorful et al., 2021), (Rastegari Kopaei et al., 2021)

Note: ® = Reverse coding.

questionnaire's internal consistency, yielding Cronbach's alpha coefficients ranging from 0.78 to 0.92, indicating that the questionnaire subscales were sufficiently reliable.

3.4. Participants

After testing for reliability and validity, the questionnaire was converted to its online format using Google Forms, and the survey link was distributed via the researchers' social media platforms to have maximum contribution from online users. This method was applied to reduce COVID-19-induced mobility restrictions and ensure social distancing measures were in place. Due to the expanding internet connectivity coupled with increased ownership of mobile phones among Nigerians, data could be retrieved from different areas of the country, which would not have been feasible with on-site data collection. This ensured a relatively broad reach of the invitation to participate in the survey (Fig. 2).

The characteristics of the study respondents are shown in Table 2. The average age of the participants was 47.99 years. Most respondents (62.3%) were males, and a small minority (5.9%) did not have Nigerian nationality. Most participants had enjoyed an education up to the tertiary level, with only one-tenth without an education. Single-use masks were most prevalently used (89.5%), followed by cloth/fabric (8.3%) and other forms of masks (2.2%) respectively.

3.5. Data analysis

After checking for missing values, 1183 responses were analyzed using IBM SPSS AMOS software. Structural equation modeling (SEM) assessed the relationship between the TPB constructs and the respondents' safe disposal of used FM. Confirmatory Factor Analysis (CFA) was applied to evaluate the model's sufficiency, looking at the model's

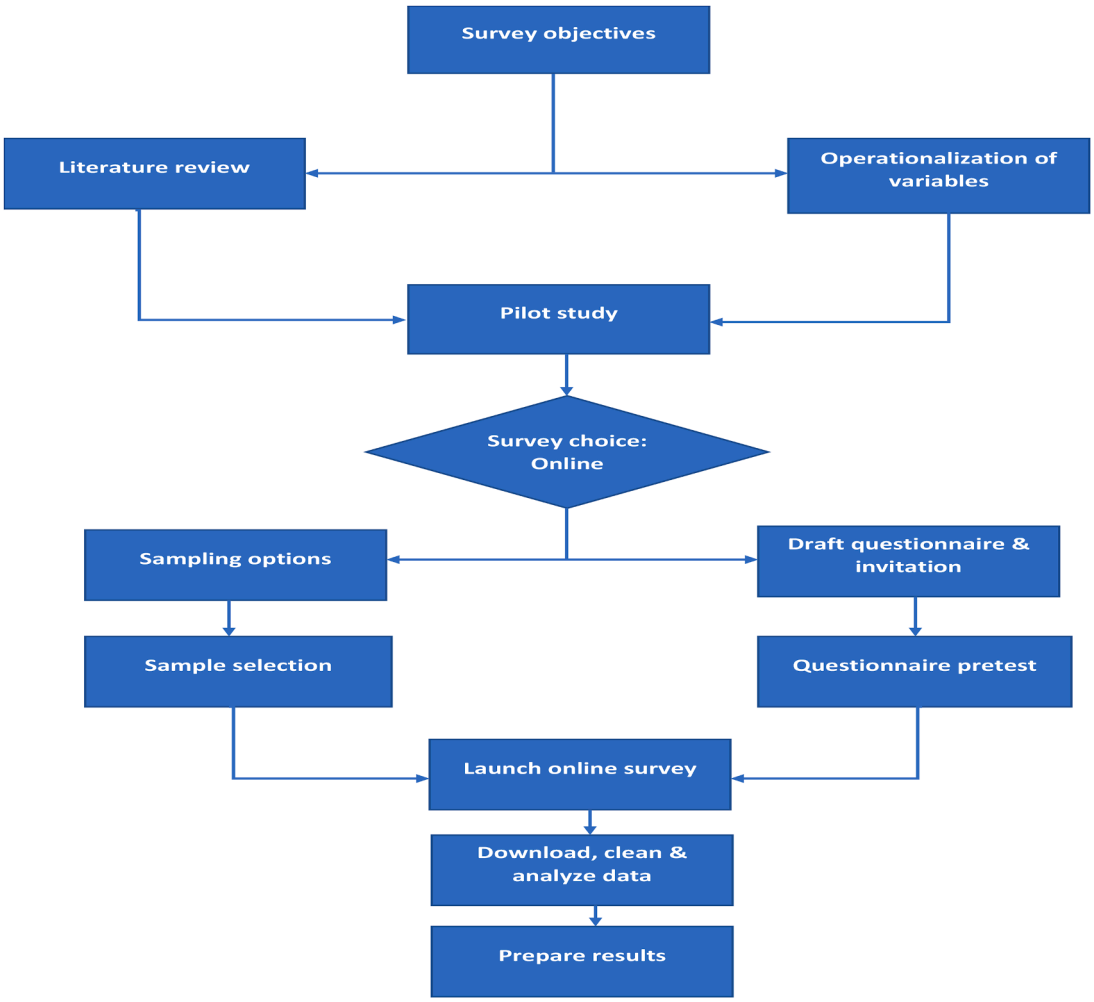

Fig. 2. Flowchart of the methodology.

Table 2
Characteristics of the study participants.

Variables	Frequency ($n = 1183$)	Percentage (%)
Age (years)		
< 21	29	2.5
21 – 40	380	32.1
41 – 60	504	42.6
≥ 61	270	22.8
Mean ± SD	47.99 ± 15.66	
Min – Max	18 – 87	
Gender		
Male	737	62.3
Female	446	37.7
Nationality		
Nigerians	1113	94.1
Foreigners	70	5.9
Education status		
No education	114	9.6
Primary education	265	22.4
Secondary education	259	21.9
Tertiary education	545	46.1
Masks type		
Single-use	1059	89.5
Cloth/fabric	98	8.3
Others	26	2.2

goodness-of-fit, discriminant validity, convergent validity, and reliability. Model testing and examination of the causal relationships among the variables within the model were done. This analysis uses different goodness-of-fit indices, including the ratio of Chi-square (χ^2) to the degree of freedom (df) (relative or normed Chi-square), comparative-fit index (CFI), Incremental Fit Index (IFI), goodness-of-fit index (GFI), Adjusted GFI (AGFI), Root Mean Squared Error Approximation (RMSEA), and Root Mean Square Residual (RMR) (Ahmmadi et al., 2021). Moreover, Cohen's impact value (f^2) was applied to assess the effect size of the extended model. Convergent validity was assessed using the item loading of the respective constructs, composite reliability (CR) and average variance extracted (AVE). It was proposed that the factor loadings of constructs should be greater than or equal to 0.6 (Chin et al., 1997), CR greater than 0.6 (Bagozzi and Yi, 1988) and AVE greater than 0.5 thresholds, respectively (Fornell and Larcker, 1981). Discriminant validity was achieved when the AVE of each of the constructs was greater than Maximum Shared Variance (MSV) and Average Shared Variance (ASV) (Henseler et al., 2015).

4. Results

4.1. Measurement model

To assess the adequacy of the models, a first-order CFA was conducted to examine the fit of both original and extended TPB models. The results indicated that each measurement model fit appropriately (Table 2). The standardized factor loading (ƛ) of all constructs in the original TPB ranged from 0.612 to 0.913. However, the factor loading was up to 0.930 in the extended TPB. This implied that the loading exceeded the recommended value of 0.60 ($p < 0.05$) (Chin et al., 1997).

Besides, each construct's AVE and CR values were above the threshold of 0.50 and 0.70, respectively. These findings indicated that all the assessed items in the two models showed robust convergent validity and reliability. Discriminant validity was measured by comparing the AVE values of each construct to ASV and MSV, which was subsequently higher than both. This confirmed that discriminant validity was achieved (Table 3). The goodness-of-fit indices were all within the recommended cut-off values (Coşkun and Özbük, 2020).

4.2. Structural models

The contribution of the extended TPB variables to intention and FM disposal behavior was tested via two structural models testing the original and an extended version of the TPB, respectively.

4.2.1. The original TPB

A test of the original TPB showed that ATT, PBC and SN in combination explained 65% of the variance of the respondents' behavior (safely disposing of their used FM) in Fig. 3. ATT, PBC and SN had a positive and significant relationship with BI, and BI had a positive and significant impact on FM disposal behavior. BI and PBC accounted for 59.3% of the variance in participants' DB.

4.2.2. The extended TPB

The analyses for the extended TPB showed a direct relationship between AC and ATT and with DB (Fig. 4) but no significant direct relationship between AC and BI to the disposal of FM. On the other hand, PIB had a direct negative and significant relationship with PCB, AC, BI and DB. Adding PIB and AC improved the explanatory power of the TPB model by 12.8%. The impact value (f^2) for the extended TPB model was calculated using the Cohen formula (Cohen, 2013) to evaluate the impact of the two new variables. The formula is based on the R^2 value with suggested predictors included to (R^2incl) and excluded (R^2excl) from the model: $f^2 = (R^2\text{incl} - R^2\text{excl})/(1 - R^2\text{incl})$. In addition, Cohen's impact values were grouped into small (0.02), medium (0.15) and large (0.35) effect sizes. The extended model f^2 value was 0.48, showing a large impact of the two added variables (Table 4), implying that the added variables significantly impacted FM disposal behavior.

5. Discussion

This study aimed to identify the psychological determinants of used face mask disposal in Nigeria, drawing on an extended version of the Theory of Planned Behavior (TPB). The findings enrich and expand waste management research by corroborating the validity of the TPB model in explaining pro-environmental behavior. The original and extended versions of the TPB could explain the determinants of used face mask disposal behavior among Nigerian residents. The extended TPB applied in this study, which added the variables of awareness of consequences (AC) and perceived institutional barriers (PIB) to the original

Table 3
Confirmatory factor analysis.

Construct	Measurement items	Original TPB			Extended TPB		
		λ̂	t-values	Reliability and validity statistics	λ̂	Reliability and validity statistics	t-values
DB	DB_1	0.879	Fixed	CR = 0.861	0.882	CR = 0.873	Fixed
	DB_2	0.652	12.534	AVE = 0.568	0.687	AVE = 0.569	12.757
	DB_3	0.761	13.712	MSV = 0.243	0.759	MSV = 0.261	13.911
	DB_4	0.825	18.232	ASV = 0.321	0.899	ASV = 0.346	18.351
	DB_5	0.612	10.912		0.657		10.683
	DB_6	0.818	18.911		0.888		18.676
	DB_7	0.799	18.011		0.801		17.798
BI	BI_1	0.857	Fixed	CR = 0.873	0.870	CR = 0.815	Fixed
	BI_2	0.797	11.435	AVE = 0.589	0.731	AVE = 0.587	11.510
	BI_3	0.773	13.221	MSV = 0.285	0.782	MSV = 0.273	13.335
	BI_4	0.889	17.755	ASV = 0.363	0.881	ASV = 0.391	17.821
	BI_5	0.910	19.110		0.930		19.711
ATT	ATT_1	0.672	Fixed	CR = 0.864	0.677	CR = 0.864	Fixed
	ATT_2	0.883	13.635	AVE = 0.581	0.820	AVE = 0.581	13.995
	ATT_3	0.820	13.384	MSV = 0.389	0.870	MSV = 0.395	13.687
	ATT_4	0.764	10.773	ASV = 0.287	0.751	ASV = 0.271	10.846
	ATT_5	0.899	19.111		0.901		20.221
PBC	PBC_1	0.728	Fixed	CR = 0.887	0.788	CR = 0.897	Fixed
	PBC_2	0.837	15.735	AVE = 0.60	0.869	AVE = 0.598	15.681
	PBC_3	0.797	14.248	MSV = 0.383	0.801	MSV = 0.412	14.364
	PBC_4	0.789	12.359	ASV = 0.291	0.731	ASV = 0.247	12.487
SN	SN_1	0.898	Fixed	CR = 0.869	0.897	CR = 0.893	Fixed
	SN_2	0.637	12.973	AVE = 0.671	0.633	AVE = 0.679	12.951
	SN_3	0.824	17.115	MSV = 0.169	0.826	MSV = 0.167	17.233
				ASV = 0.201		ASV = 0.213	
PIB	PIB_1				0.913	CR = 0.842	Fixed
	PIB_2				0.815	AVE = 0.534	13.525
	PIB_3				0.773	MSV = 0.297	12.855
	PIB_4				0.830	ASV = 0.199	11.211
	PIB_5				0.859		17.913
AC	AC_1				0.785	CR = 0.891	Fixed
	AC_2				0.747	AVE = 0.537	10.768
	AC_3				0.672	MSV = 0.271	9.796
						ASV = 0.194	

Note: Original TPB model: $\chi^2/df = 2.917$, CFI = 0.952, IFI = 0.958, AGFI = 0.921, GFI = 0.902, RMR = 0.064, RMSEA = 0.071; **Extended TPB:** $\chi^2/df = 2.785$, CFI = 0.927, IFI = 0.980, AGFI = 0.929, GFI = 0.905, RMR = 0.060, RMSEA = 0.069.

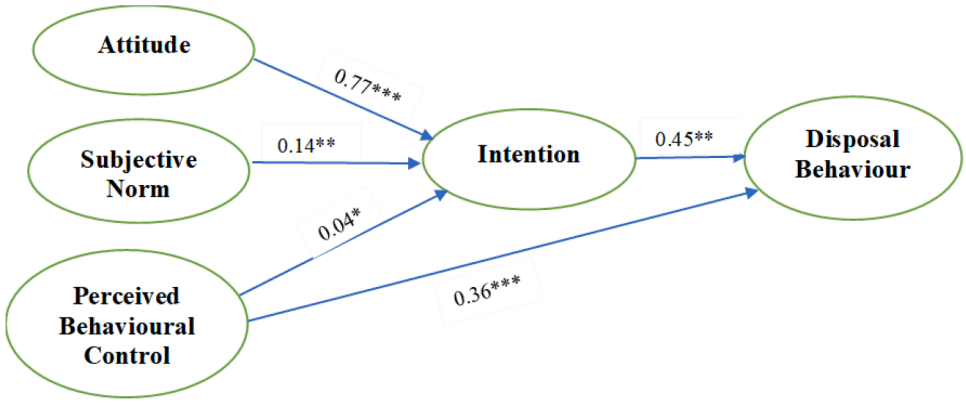

Fig. 3. The structural equation modelling of the original TPB.

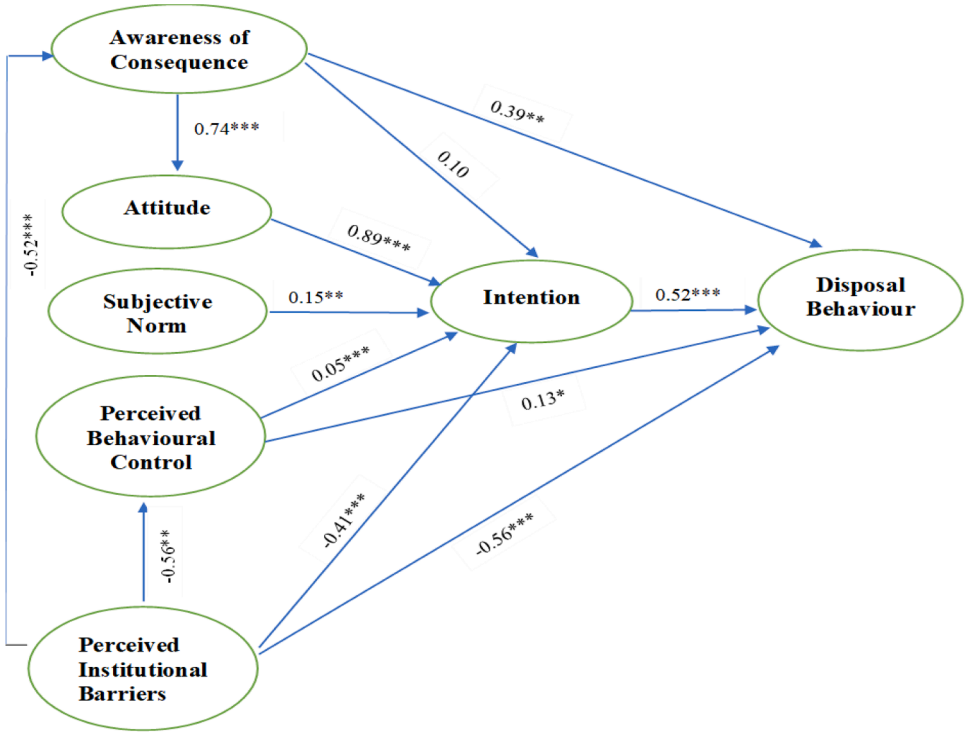

Fig. 4. The structural model of the extended TPB.

model consisting of attitudes (ATT), subjective norms (SN) and perceived behavioral control (PBC) to explain behavioral intention (BI) and actual disposal behavior (DB), had a better fit with the data than the original TPB model. Specifically, the structural equation analysis showed that whereas in the original model, ATT, PBC and SN explained 65% of the variance in the respondents' BI and BI and PBC accounted for 59.3% of the variance in DB, the extended TPB model explained 72.6% of the variance in DB. The addition of the two variables thus adds significant explanatory power to the model.

The structural equation analysis also revealed that the original and extended model's attitude is the strongest predictor of the behavioral intention to dispose of worn face masks responsibly. A strong relationship between ATT and BI was also reported for other pro-environmental behavior. For instance, Soomro et al. (2022) reported that a strong attitude towards solid waste management positively influenced the intention to recycle solid waste. Similarly, attitudes were the most significant behavioral predictor of domestic waste management among university students in China (Pan et al., 2022), and intentions are significantly enhanced if people have high positive evaluations regarding waste management (Shi et al., 2021).

As predicted by the TPB, subjective norms also positively and significantly impacted people's intention to dispose of used face masks properly. As subjective norms refer to peoples' beliefs of what other people find appropriate (i.e., injunctive norms) or typically do themselves (i.e., descriptive norms) (De Bruijn, 2010), these findings show that the likelihood of people adopting an intention towards proper disposal of used face masks increases if significant others approve of the behavior and/or perform it themselves. The fact that people conform to societal norms to adopt socially desirable pro-environmental behaviors has been reported elsewhere (Al Mamun et al., 2018) and thus appears to apply to sustainable face mask disposal.

A significant positive influence on peoples' intention and behavior to properly dispose of used face masks was also found for perceived behavioral control. The effect of PBC on intention and actual behavior is again in line with the TPB - Ajzen (2020) stated that a person would only be eager to perform a task that they perceive as being within their control - and has been reported in previous studies regarding waste management. For instance, Hu et al. (2021) reported that PBC positively

Table 4
Hypothesis testing based on the standardized path coefficients.

Path analysis	Original TPB			Extended TPB		
	Coefficient	t-value	P-value	Coefficient	t-value	P-value
ATT→BI	0.767***	26.721	0.000	0.890***	47.829	0.000
SN→BI	0.136**	6.431	0.000	0.154**	3.386	0.000
PBC→BI	0.040*	1.970	0.027	0.048*	4.785	0.000
PBC→DB	0.361**	11.091	0.010	0.132*	6.787	0.013
BI→DB	0.445***	13.660	0.000	0.519***	13.725	0.000
AC→ATT				0.744***	38.282	0.000
AC→BI				0.100	3.622	0.058
AC→DB				0.390**	12.654	0.000
PIB→DB				-0.557***	-19.824	0.000
PIB→BI				-0.412**	-17.129	0.000
PIB→PBC				-0.407**	-16.901	0.000
PIB→AC				-0.523***	-18.189	0.000
R^2	0.593			0.726		
f^2				0.48		

Note: All regression coefficients are standardized. *, **, *** means statistical significance at 10%, 5% and 1%, respectively.

and significantly influenced people's behavior towards waste disposal. Similarly, Coşkun and Özbük (2020) reported a positive and significant relationship between PBC and the intention to dispose of waste. Thus, the more people perceive that responsible disposal of used face masks is within their control, the more likely they are to show an intention and actual behavior to dispose of the masks responsibly.

Again, in conformity with the TPB, a significant positive relationship was also found between respondents' intention to dispose of their used face masks responsibly and their actual disposal behavior. Respondents with lower levels of intention to dispose of used face masks in an environmentally friendly way reported a lower level of waste disposal and vice versa. This concurs with the results of other studies in waste management (Barone et al., 2019; Coşkun and Özbük, 2020), noting that an increase in intention contributes to a positive change in individual waste management behaviors. According to Wu et al. (2022), intention is even the most direct predictor of behavior.

While the above confirms the value of the TPB to explain face mask disposal behavior, the addition of two new variables enhances the explanatory value of the model. Firstly, awareness of the consequences of inappropriate disposal of face masks had a direct and positive relationship with the respondents' attitudes, implying that individuals who are aware of the environmental repercussions of wrongful disposal of face masks tend to have a more positive attitude towards safe disposal. Interestingly, there was no significant direct relationship between an awareness of the consequences and the behavioral intention to dispose of face masks responsibly. This is consistent with the results of a study by Si et al. (2020) regarding the impact of AC on the BI of bike sharing and could be explained by the fact that people may be aware of the demerits of inappropriate disposal of used face masks but may not have the intention to dispose due to lack disposal facilities. On the other hand, the indirect relationship between awareness of consequences and the intention to dispose responsibly via attitudes is in line with findings reported by Rastegari Kopaei et al. (2021) and (Arkorful et al., 2021). A significant direct relationship was also found between awareness of consequences and actual disposal behavior, which was also reported by other scholars (Coşkun and Özbük, 2020).

Lastly, our results also revealed a direct and significant negative relationship between perceived institutional barriers on the one hand and awareness of consequences, perceived behavioral control, behavioral intentions and actual disposal behavior on the other hand. So, the more people perceive more institutional barriers towards face mask disposal, the less they are aware of the environmental consequences of inadequate disposal, feel in control of disposal and perform or intend to perform environmentally responsible disposal. Institutional barriers such as lack of facilities, inadequate policies, poor communication, or lack of incentives were also found to hinder effective waste management in Thailand (Yukalang et al., 2017), while others have also argued that situational factors can adversely influence one's controllability and environmental concern regarding a behavior (Francis et al., 2004; Takács-Sánta, 2007). Like our findings, they suggest that institutional support and incentives (including infrastructures such as waste disposal facilities) are vital to encourage pro-environmental behaviors (Carducci et al., 2021). As such, people would only dispose of their used face masks properly if the authorities provided crucial infrastructures.

5.1. Policy implications

Based on the results of our study, we can propose policy recommendations to strengthen the responsible, safe disposal of used face masks during the pandemic. Since our findings suggest that attitudes are the most significant predictor of the intention to dispose of used face masks and that intention, along with AC and PIB, are the most significant direct predictors of face mask DB, we believe that these factors should be targeted in government policies or programs promoting face mask use. Awareness raising about environmentally responsible disposal of worn face masks should be integrated into programs promoting the use of face masks to protect against the spread of COVID-19. This can be achieved through environmental education via mass media and social media to raise the public's awareness about the consequences of unsafe and irresponsible disposal and change their attitudes towards disposing of used face masks. For instance, the dominant sources of news in Nigeria are broadcast radio (77.4%) (Broadcasting Board of Governors (BBG), 2014), followed by television and social media platforms such as Twitter and Facebook. Environmental education messages could be disseminated via these mass media in English and other local languages to sensitize the public on the danger of improper face mask waste management. With an improved attitude, more people would dispose of face mask wastes in an environmentally friendly manner, which would also influence and enhance the subjective norm towards appropriate disposal and thus encourage others. For example, policy makers could also launch public campaigns that highlight successful green initiatives or showcase environmental champions as role models for others to follow.

Similarly, government agencies and NGOs should leverage more on the use of the Internet and social media platforms to change people's subjective norms concerning the disposal of used face masks. This can be achieved by empowering social media influencers with large groups of followers to encourage the responsible disposal of face masks after use, to avoid cross-contamination and the spread of COVID-19 and to reduce waste. NGOs can also help provide relevant content concerning the disposal of used face masks. Furthermore, color-coded waste bins should be provided in public spaces, households, medical facilities and rural or urban communities to facilitate adequate disposal of used face masks. Such facilities would additionally ensure and expedite efficient waste collection, separation and transportation with a view to recycling, incineration or disposal.

To reduce institutional barriers, governments and media agencies should develop instruments to manage the inappropriate disposal of used face masks effectively. These instruments could include text messages emphasizing and reminding people of improper face mask disposal's health and environmental detriments. A public-private partnership between government agencies and private institutions can help provide more waste bins for face mask disposal. On the other hand, face masks manufacturers could be asked to provide information and guidelines on the proper disposal of their products as well as warnings of the danger of inadequate face masks disposal and face mask vendors should be encouraged to educate their customers on proper disposal of face masks through verbal communication or posters. Finally, the manufacturing and use of cloth or fabric masks that can be washed and reused could be encouraged to reduce waste, and healthcare facilities could be asked to provide for the disposal of FM and related waste to

avoid litter and environmental contamination.

5.2. Study limitations and direction for future studies

One limitation of this study is the online and non-probabilistic sampling method used to recruit participants. This method may have led to self-selection bias, limiting the generalizability of the study's findings. Future studies could address this limitation by using a more diverse sample of participants and incorporating probabilistic sampling methods to increase the generalizability of the results. Another limitation is the use of self-reported measures, which may be subject to response bias. Future studies could use objective measures or multiple data collection methods to validate self-reported measures. This study only focused on FM disposal behavior, and future research could expand the scope to include other pro-environmental behaviors.

Additionally, the study only examined the TPB model's original and extended versions, and other theoretical models could be explored to provide a more comprehensive understanding of environmental behavior. Further research could also investigate the effectiveness of interventions aimed at promoting FM disposal behavior. This could include developing and implementing targeted interventions based on the factors identified in this study to improve the effectiveness of waste management programs. Moreover, future studies could explore the role of individual differences, such as personality traits, in influencing FM disposal behavior. Such research could provide valuable insights into how different population subgroups respond to waste management interventions. As the study included participants from a single country, future research could include a cross-cultural analysis to examine whether the TPB model's predictive power varies across different cultures and contexts. In summary, this study provides valuable insights into the factors influencing FM disposal behavior and highlights the importance of considering additional variables to improve the TPB model's predictive power. However, future research could address the limitations of this study and provide a more comprehensive understanding of the factors influencing pro-environmental behavior.

6. Conclusion

To the best of the authors' knowledge, this study identified psychological factors influencing people's disposal of used face masks during the COVID-19 pandemic for the first time, using an extended version of the Theory of Planned Behavior. Structural equation modeling showed the suitability of both the original TPB and an extended version of the model to explain the responsible disposal of used face masks. Based on their order of significance, attitude, subjective norms, and perceived behavioral control are found to be direct predictors of the intention to dispose of used face masks responsibly, while along with behavioral intention, awareness of the consequences of inappropriate disposal and institutional barriers are direct predictors of disposal behavior. Awareness of consequences plays a crucial role in shaping people's attitude towards disposing of used face masks in an environmentally responsible way. At the same time, perceived institutional barriers may hinder that behavior directly or indirectly via perceived behavioral control and awareness of consequences. Based on these results, it is suggested that decision-makers and relevant government agencies should concentrate on making the public aware of the consequences of inappropriate disposal of used face masks, improving their attitudes towards environmentally sound disposal, and reducing perceived institutional barriers to appropriate disposal.

CRediT authorship contribution statement

Oluseye O. Oludoye: Conceptualization, Methodology, Project administration, Investigation, Formal analysis, Writing – original draft. **Stephan Van den Broucke:** Writing – review & editing, Visualization, Validation. **Xi Chen:** Writing – review & editing, Visualization. **Nuta Supakata:** Writing – review & editing, Validation. **Lanrewaju A. Ogunyebi:** Project administration, Data curation. **Kelechi L. Njoku:** Writing – review & editing, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.rcradv.2023.200148.

References

Abadi, B., Mahdavian, S., Fattahi, F., 2021. The waste management of fruit and vegetable in wholesale markets: intention and behavior analysis using path analysis. J. Clean. Prod. 279, 123802.

Adu-Gyamfi, G., Song, H., Nketiah, E., Obuobi, B., Adjei, M., Cudjoe, D., 2022. Determinants of adoption intention of battery swap technology for electric vehicles. Energy 251, 123862.

Ahmmadi, P., Rahimian, M., Movahed, R.G., 2021. Theory of planned behavior to predict consumer behavior in using products irrigated with purified wastewater in Iran consumer. J. Clean. Prod. 296, 126359.

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50 (2), 179–211.

Ajzen, I., 2015. The theory of planned behaviour is alive and well, and not ready to retire: a commentary on Sniehotta, Presseau, and Araújo-Soares. Health Psychol. Rev. 9 (2), 131–137.

Ajzen, I., 2020. The theory of planned behavior: frequently asked questions. Hum. Behav. Emerg. Technol. 2 (4), 314–324.

Akinsehinwa, F.O., Adeniran, A.O., Olorunfemi, S.O., Aina, O.M., 2022. Level of Adherence to COVID-19 Preventive Measures: case Study of FUTA Shuttle Bus. Biomed. J. Scient. Tech. Res. 41 (4), 32968–32976.

Al Mamun, A., Mohamad, M.R., Yaacob, M.R.B., Mohiuddin, M, 2018. Intention and behavior towards green consumption among low-income households. J. Environ. Manage. 227, 73–86.

Amuah, E.E.Y., Agyemang, E.P., Dankwa, P., Fei-Baffoe, B., Kazapoe, R.W., Douti, N.B., 2022. Are used face masks handled as infectious waste? Novel pollution driven by the COVID-19 pandemic. Resour. Conserv. Recycl. Adv. 13, 200062.

Ao, Y., Zhu, H., Wang, Y., Zhang, J., Chang, Y., 2022. Identifying the driving factors of rural residents' household waste classification behavior: evidence from Sichuan, China. Resour. Conserv. Recycl. 180, 106159.

Arkorful, V.E., Lugu, B.K., Shuliang, Z., 2021. Unearthing mask waste separation behavior in COVID-19 pandemic period: an empirical evidence from Ghana using an integrated theory of planned behavior and norm activation model. Curr. Psychol. 1–16.

Babatola, A., Solomon, O., Ojo, T., Solomon, O., Olatunya, O., Fadare, J., Oluwadiya, K., 2023. Knowledge, Practice and Technique of Facemask Usage among Healthcare Workers in a Tertiary Hospital in Ado-Ekiti, Nigeria. Scient. African e01559.

Bagozzi, R.P., Yi, Y., 1988. On the evaluation of structural equation models. J. Acad. Market. Sci. 16, 74–94.

Barone, A.M., Grappi, S., Romani, S., 2019. The road to food waste is paved with good intentions": when consumers' goals inhibit the minimization of household food waste. Resour. Conserv. Recycl. 149, 97–105.

Broadcasting Board of Governors (BBG). (2014). *Contemporary media use in Nigeria.* Retrieved April 2 from https://www.usagm.gov/2014/04/30/bbg-research-series-contemporary-media-use-in-nigeria/.

Brüssow, H., Zuber, S., 2022. Can a combination of vaccination and face mask wearing contain the COVID-19 pandemic? Microb. Biotechnol. 15 (3), 721–737.

Carducci, A., Agodi, A., Ancona, C., Angelini, P., Bagordo, F., Barbone, F., Birbaum, L., Carreri, V., Casuccio, A., Conti, A., 2021. Impact of the environment on the health: from theory to practice. Environ. Res. 194, 110517.

Chin, W.W., Gopal, A., Salisbury, W.D., 1997. Advancing the theory of adaptive structuration: the development of a scale to measure faithfulness of appropriation. Inform. Syst. Res. 8 (4), 342–367.

Coşkun, A., Özbük, R.M.Y., 2020. What influences consumer food waste behavior in restaurants? An application of the extended theory of planned behavior. Waste Manage. 117, 170–178.

Cudjoe, D., Nketiah, E., Obuobi, B., Adjei, M., Zhu, B., Adu-Gyamfi, G., 2022. Predicting waste sorting intention of residents of Jiangsu Province, China. J. Clean. Prod. 366, 132838.

De Bruijn, G.-J, 2010. Understanding college students' fruit consumption. Integrating habit strength in the theory of planned behaviour. Appetite 54 (1), 16–22.
Ebekozien, A., Aigbavboa, C., Ayo-Odifiri, S.O., 2022. Root cause of factors enhancing the spread of coronavirus disease 2019 pandemic in Nigerian informal urban settlements: issues and possible solutions. Int. Plan. Stud. 27 (1), 44–61.
ERA/FoEN. (2021). *COVID-19 and plastic pollution crisis in Nigeria*. Retrieved April 1 from https://www.foei.org/resources/publications/covid-19-and-plastic-pollution-crisis-in-nigeria.
Fadare, O.O., Okoffo, E.D., 2020. Covid-19 face masks: a potential source of microplastic fibers in the environment. Sci. Total Environ. 737, 140279.
Fang, W.-T., Huang, M.-H., Cheng, B.-Y., Chiu, R.-J., Chiang, Y.-T., Hsu, C.-W., Ng, E., 2021. Applying a comprehensive action determination model to examine the recycling behavior of Taipei city residents. Sustainability 13 (2), 490.
Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Market. Res. 18 (1), 39–50.
Francis, J., Eccles, M.P., Johnston, M., Walker, A., Grimshaw, J.M., Foy, R., Kaner, E.F., Smith, L., & Bonetti, D. (2004). Constructing questionnaires based on the theory of planned behaviour: a manual for health services researchers.
Goh, E., Ritchie, B., Wang, J., 2017. Non-compliance in national parks: an extension of the theory of planned behaviour model with pro-environmental values. Tour. Manage. 59, 123–127.
Goldberg, C., & Court, E. (2021). *Infectious Omicron drives more Americans to up mask game to N95s*. Bloomberg. Retrieved April 2 from.
Henseler, J., Ringle, C.M., Sarstedt, M., 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J. Acad. Market. Sci. 43, 115–135.
Hou, E.-J., Hsieh, Y.-Y., Hsu, T.-W., Huang, C.-S., Lee, Y.-C., Han, Y.-S., Chu, H.-T., 2022. Using the concept of circular economy to reduce the environmental impact of COVID-19 face mask waste. Sustain. Mater. Technol. 33, e00475.
Hu, J., Tang, K., Qian, X., Sun, F., Zhou, W., 2021. Behavioral change in waste separation at source in an international community: an application of the theory of planned behavior. Waste Manage. 135, 397–408.
Hufford, A. (2022). *3 M's N95 mask sales climb, lifting revenue as omicron drives demand*. The Wall Street Journal. Retrieved April 2 from https://www.wsj.com/articles/3ms-n95-mask-sales-climb-lifting-revenue-as-omicron-drives-demand-11643136555.
Idowu, G.A., Olalemi, A.O., Aiyesanmi, A.F., 2023. Environmental impacts of covid-19 pandemic: release of microplastics, organic contaminants and trace metals from face masks under ambient environmental conditions. Environ. Res. 217, 114956.
Idowu, O.O., 2013. Challenges of urbanization and urban growth in Nigeria. Am. J. Sustain.Cities Soc. 2 (1), 79–94.
Irfan, M., Akhtar, N., Ahmad, M., Shahzad, F., Elavarasan, R.M., Wu, H., Yang, C., 2021. Assessing public willingness to wear face masks during the COVID-19 pandemic: fresh insights from the theory of planned behavior. Int. J. Environ. Res. Public Health 18 (9), 4577.
Khan, O., Daddi, T., Slabbinck, H., Kleinhans, K., Vazquez-Brust, D., De Meester, S., 2020. Assessing the determinants of intentions and behaviors of organizations towards a circular economy for plastics. Resour. Conserv. Recycl. 163, 105069.
Lee, Y., Li, J.Y.Q., 2021. The role of communication transparency and organizational trust in publics' perceptions, attitudes and social distancing behaviour: a case study of the COVID-19 outbreak. J. Conting. Crisis Manage. 29 (4), 368–384.
Li, J., Liu, X., Zou, Y., Deng, Y., Zhang, M., Yu, M., Wu, D., Zheng, H., Zhao, X., 2021. Factors affecting COVID-19 preventive behaviors among university students in Beijing, China: an empirical study based on the extended theory of planned behavior. Int. J. Environ. Res. Public Health 18 (13), 7009.
Limon, M.R., Vallente, J.P.C., Cajigal, A.R.V., Aquino, M.U., Aragon, J.A., Acosta, R.L., 2022a. Unmasking emerging issues in solid waste management: knowledge and self-reported practices on the discarded disposable masks during the COVID-19 pandemic in the Philippines. Environ. Chall. 6, 100435.
Meng, B., Han, H., 2018. Investigating individuals' decision formation in working-holiday tourism: the role of sensation-seeking and gender. J. Travel Tour.. Market. 35 (8), 973–987.
Mghili, B., Analla, M., Aksissou, M., 2022. Face masks related to COVID-19 in the beaches of the Moroccan Mediterranean: an emerging source of plastic pollution. Mar. Pollut. Bull. 174, 113181.
Nketiah, E., Song, H., Cai, X., Adjei, M., Obuobi, B., Adu-Gyamfi, G., Cudjoe, D., 2022. Predicting citizens' recycling intention: incorporating natural bonding and place identity into the extended norm activation model. J. Clean. Prod. 377, 134425.
Nwafor, N., Walker, T.R., 2020. Plastic bags prohibition bill: a developing story of crass legalism aiming to reduce plastic marine pollution in Nigeria. Mar. Policy 120, 104160.
Obuobi, B., Tang, D., Cai, X., Nketiah, E., Adu-Gyamfi, G., 2022. Sustainable mining practices: willingness to adopt mercury-free gold mining in Ghana. J. Clean. Prod. 380, 135085.
Olewu, J. (2020). *COVID-19 effects on the environment: use and disposal of face mask in Nigeria*. Retrieved February 27 from http://sustainabledevelopmentlaws.com/2020/05/06/covid-19-effects-on-the-environment-the-use-and-disposal-of-face-mask-in-nigeria-by-olewu-joshua-uchechukwu1/.
Oyeniran, O., Chia, T., 2020. Novel coronavirus disease 2019 (COVID-19) outbreak in Nigeria: how effective are government interventions? Ethics Medic. Public Health 14, 100515.
Pan, Y., Li, M., Guo, H., Li, Y., Han, J., 2022. Influencing factors and reduction of domestic solid waste at university dormitory in Shanghai, China. Sci. Rep. 12 (1), 1–12.
Parashar, N., Hait, S., 2021. Plastics in the time of COVID-19 pandemic: protector or polluter? Sci. Total Environ. 759, 144274.
Park, J., Ha, S., 2014. Understanding consumer recycling behavior: combining the theory of planned behavior and the norm activation model. Family Consum. Sci. Res. J. 42 (3), 278–291.
Prasetyo, Y.T., Castillo, A.M., Salonga, L.J., Sia, J.A., Seneta, J.A., 2020. Factors affecting perceived effectiveness of COVID-19 prevention measures among Filipinos during enhanced community quarantine in Luzon, Philippines: integrating Protection Motivation Theory and extended Theory of Planned Behavior. Int. J. Infect. Dis.s 99, 312–323.
Rastegari Kopaei, H., Nooripoor, M., Karami, A., Petrescu-Mag, R.M., Petrescu, D.C., 2021. Drivers of residents' home composting intention: integrating the theory of planned behavior, the norm activation model, and the moderating role of composting knowledge. Sustainability 13 (12), 6826.
ReportLinker. (2021). *Face mask market - global outlook & forecast 2021-2026*. Retrieved April 2 from https://www.reportlinker.com/p05934703/Face-Mask-Market-Global-Outlook-and-Forecast.html.
Rowan, N.J., Laffey, J.G., 2021. Unlocking the surge in demand for personal and protective equipment (PPE) and improvised face coverings arising from coronavirus disease (COVID-19) pandemic–implications for efficacy, re-use and sustainable waste management. Sci. Total Environ. 752, 142259.
Roy, D., Tripathy, S., Kar, S.K., Sharma, N., Verma, S.K., Kaushal, V., 2020. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. Asian J. Psychiatr. 51, 102083.
Sarkar, B., Dissanayake, P.D., Bolan, N.S., Dar, J.Y., Kumar, M., Haque, M.N., Mukhopadhyay, R., Ramanayaka, S., Biswas, J.K., Tsang, D.C., 2022. Challenges and opportunities in sustainable management of microplastics and nanoplastics in the environment. Environ. Res. 207, 112179.
Savari, M., Gharechaee, H., 2020. Application of the extended theory of planned behavior to predict Iranian farmers' intention for safe use of chemical fertilizers. J. Clean. Prod. 263, 121512.
Sen-Crowe, B., McKenney, M., Elkbuli, A., 2020. Social distancing during the COVID-19 pandemic: staying home save lives. Am. J. Emerg. Med. 38 (7), 1519.
Shi, J.-g., Xu, K., Si, H., Song, L., Duan, K., 2021. Investigating intention and behaviour towards sorting household waste in Chinese rural and urban–rural integration areas. J. Clean. Prod. 298, 126827.
Si, H., Shi, J.-g., Tang, D., Wu, G., Lan, J., 2020. Understanding intention and behavior toward sustainable usage of bike sharing by extending the theory of planned behavior. Resour. Conserv. Recycl. 152, 104513.
Soomro, Y.A., Hameed, I., Bhutto, M.Y., Waris, I., Baeshen, Y., Al Batati, B., 2022. What influences consumers to recycle solid waste? An application of the extended theory of planned behavior in the Kingdom of Saudi Arabia. Sustainability 14 (2), 998.
Sturman, D., Auton, J.C., Thacker, J., 2021. Knowledge of social distancing measures and adherence to restrictions during the COVID-19 pandemic. Health Promot. J. Australia 32 (2), 344–351.
Takács-Sánta, A., 2007. Barriers to environmental concern. Hum. Ecol. Rev. 26–38.
Tesfaldet, Y.T., Ndeh, N.T., Budnard, J., Treeson, P., 2022. Assessing face mask littering in urban environments and policy implications: the case of Bangkok. Sci. Total Environ. 806, 150952.
Trifiletti, E., Shamloo, S.E., Faccini, M., Zaka, A., 2022. Psychological predictors of protective behaviours during the Covid-19 pandemic: theory of planned behaviour and risk perception. J. Community Appl. Soc. Psychol. 32 (3), 382–397.
Tripathi, A., Tyagi, V.K., Vivekanand, V., Bose, P., Suthar, S., 2020. Challenges, opportunities and progress in solid waste management during COVID-19 pandemic. Case Stud. Chem. Environ. Eng. 2, 100060.
University of Oxford. (2023). *Face covering policies during the COVID-19 pandemic*. Oxford COVID-19 Government Response Tracker, Blavatnik School of Government. Retrieved April 2 from https://ourworldindata.org/grapher/face-covering-policies-covid.
Wang, D., Sun, B.-C., Wang, J.-X., Zhou, Y.-Y., Chen, Z.-W., Fang, Y., Yue, W.-H., Liu, S.-M., Liu, K.-Y., Zeng, X.-F., 2020. Can masks be reused after hot water decontamination during the COVID-19 pandemic? Engineering 6 (10), 1115–1121.
Wang, F., Wu, H., Li, J., Liu, J., Xu, Q., An, L., 2022. Microfiber releasing into urban rivers from face masks during COVID-19. J. Environ. Manage. 319, 115741.
World Health Organization (WHO). (2022). *Coronavirus (COVID-19)*. Retrieved April 2 from https://covid19.who.int/.
Wu, L., Zhu, Y., Zhai, J., 2022. Understanding waste management behavior among university students in China: environmental knowledge, personal norms, and the theory of planned behavior. Front. Psychol. 12, 6528.
Yang, L., Constantino, S.M., Grenfell, B.T., Weber, E.U., Levin, S.A., Vasconcelos, V.V., 2022. Sociocultural determinants of global mask-wearing behavior. Proc. Natl. Acad. Sci. 119 (41), e2213525119.
Yukalang, N., Clarke, B., Ross, K., 2017. Barriers to effective municipal solid waste management in a rapidly urbanizing area in Thailand. Int. J. Environ. Res. Public Health 14 (9), 1013.
Yuriev, A., Dahmen, M., Paillé, P., Boiral, O., Guillaumie, L., 2020. Pro-environmental behaviors through the lens of the theory of planned behavior: a scoping review. Resour. Conserv. Recycl. 155, 104660.
Zebardast, L., Radaei, M., 2022. The influence of global crises on reshaping pro-environmental behavior, case study: the COVID-19 pandemic. Sci. Total Environ. 811, 151436.