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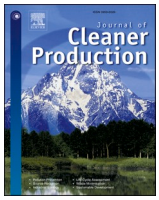

A behavioural risk perspective to plastic waste management: insights from Nigerian SMEs

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ABSTRACT

A transition to a Circular Economy (CE) is intrinsically connected to the perceived risk of moving away from the status quo of the extract-use-discard model. This study examines how small and medium enterprises (SMEs) perceive and respond the multi-dimensional risk from plastic waste mismanagement (PWM). Such risk is approximated and analysed using two different behaviour theories, the Expected Utility Theory and Protection Motivation Theory in a survey amongst 242 managers in Nigerian SMEs examining the endogenous relationship between perceived impact of PWM and perceived effectiveness in addressing it. Results indicate that plastic waste is considered as low to medium risk in the country. Perceived effectiveness to deal with PWM is correlated with perceived impact from PWM, confirming the endogenous relationship. As Nigerian firms seem to prefer low-cost and low-commitment actions to deal with PWM such as investing in local packaging materials, focusing on promotional and educational campaigns might move the needle in adopting CE practices.

1. Introduction

Implementing the circular economy (CE) concept is expected to support a transition towards sustainable development (Santolin et al., 2023). Within a CE, plastics are envisioned to be used as part of loops in the reuse and recycling of materials; transitioning to such an economy from the usual take-use-discard model is of the biggest challenges in achieving CE (Hahladakis et al., 2024). Plastic waste presents a major obstacle to circular economy transitions, especially in developing countries that must balance rapid economic growth with sustainable practices. Plastic waste also posits an environmental threat, with African countries in particular reporting the highest numbers of mismanaged waste per capita compared to all other regions of the world (Meijer et al., 2021). Population growth and increased emissions from the waste sector are considered some of the major threats for Africa (Mutezo et al., 2020) with 80 % of sub-Saharan African landfills being classified either as open dumpsites or controlled tipping sites amplifying the threats of contaminate leaching, groundwater contamination and air pollution (Idowu et al., 2019). Waste generation in Africa is forecasted to double by 2030 Kaza et al., 2018 or 344 Mt of plastic consumption by 2030, with Nigeria alone contributing to 16.9 % of all such consumption (Babayemi et al., 2019). Given the increasing population and economic growth, issues surrounding plastic waste management in Africa are likely to be exacerbated and therefore require examination.

Conceptualising and treating plastic waste mismanagement (PWM) as a risk or a threat to societies allows for examining the likelihood of a transition to a CE. Mismanaged plastic waste therefore can be seen as a threat that requires adaptive actions that can eventually lead to a CE adoption, either at the country or firm-level. Several barriers exist to the adoption of a CE which can lead to plastic waste mismanagement which, in turn, presents a threat to human health and economic welfare ((Kaza et al., 2018; Mutezo et al., 2020; Ilango, 2024). Financial barriers are considerable, with developing, procuring substitute goods and packaging as well as sustainable plastic in consumer goods being the major ones (Babayemi et al., 2019). Technological know-how in constructing (and financing) sanitary landfills is another major barrier (Rahmasary

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et al., 2019). Behavioural and lifestyle choices are also instrumental to the increased rate of plastic waste use and disposal in African countries (Mutezo et al., 2020). At the firm level, corporate norms and pro-environmental behaviour of managers has been found to affect corporate responsibilities internally to protect the environment (Chan et al., 2022). Remaining at the firm level, structural aspects of the firm such as resource availability and eco-innovative behaviour have been found to impede an adoption of CE practices while the institutional environment the firm operates has been found to accelerate CE adoption (Choudhary et al., 2022). Overall, in Africa both the public and skilled individuals claim multiple socio-cultural, political and financial factors impeding a transition to CE (Kolade et al., 2022).

Explaining firm behaviour with respect to CE actions taken (or the lack of uptake) requires empirical research based on by decision-making theories. To do so, one can integrate economic and psychological theories in empirical research (Mathew et al., 2023; Raghu and Rodrigues, 2020). As mismanaged plastic waste presents such a challenge to a CE transition, it can be considered as a risk both to health when improperly disposed or handled (Kedzierski et al., 2020) and as a financial risk to firms to dispose and deal with potential fines and environmental regulations (Diaz-Barriga-Fernandez et al., 2018). Yet, most studies approach PWM through a behavioural or technical lens, neglecting the perceived risk and motivation structures that shape business responses. In detail, studies examining the behavioural drivers of the public behind solid waste management using various behavioural theories abound (the review of Raghu and Rodrigues (2020) mention 80 such studies, primarily in developed countries). Empirical studies using such theories on firm behaviour with respect to risk of plastic waste mismanagement however are scarce (e.g., Chan et al., 2022; Islam et al., 2024; Choudhary et al., 2022) while studies examining the endogenous relationship between perceived impact of plastic waste and perceived effectiveness in addressing it are absent. Addressing the gap in empirical studies using behavioural theories on the topic of PWM requires addressing both economic and risk-related motivations as observed behaviour is determined by both (Botzen et al., 2019).

Therefore, this study aims to fill this knowledge gap by a) integrating insights from two well-established economic and psychological theories used in adaptation and vulnerability to risk literature to b) attempt to analyse firm behaviour in an African country with respect to risk from plastic waste mismanagement. The rest of the study is organised as follows: Section 2 reviews the economic and psychological theories used to explain the perceived impact and effectiveness in managing plastic waste and introduces the case study focus, Section 3 presents the methodological approach and the data used to validate the hypotheses, Section 4 discusses the results and Section 5 discusses the empirical findings and provides managerial recommendations.

2. Literature review

This paper examines economic and social psychological theories factors influencing on firm decision-making under risk. Risk is conceptualised as the risk associated with management (with regards to procuring, handling or accumulation) of plastics (MacLeod et al., 2021), in the context of adopting circular economy practices in businesses. To unpack these factors, this paper combines economic theory with a social psychological theory. The economic theory examined is the Expected Utility Theory (EUT) and the social psychological one is Protection Motivation Theory (PMT). EUT is the traditional neoclassical model of individual behaviour used in the field of economics, with Prospect Theory being later introduced to address issues around risk-dependent choices (Chung et al., 2019). EUT underpins both individual and society-wide analysis of decision-making (Buchholz and Schymura, 2012) with the method seeing some use in studies examining adaptation behaviour to new technologies (e.g., Borges et al., 2015). PMT, first introduced by Rogers (1983), examines human behaviour in or while anticipating adversity and conceptualises coping behaviour and appraisal of perceived risks (Cummings et al., 2021) and therefore departs from pure economic-agent behaviour. Outside of health risk appraisal, PMT has seen wide application in case studies evaluating climate-related hazards (Hu et al., 2022; Bubeck et al., 2018; Babcicky and Seebauer, 2019; Botzen et al., 2019; Tasantab et al., 2022) and less on other adaptation risks such as health risks to tourists (Wang et al., 2019) and food safety risk communication (Zhu et al., 2022). Combined, they have only been used to examine household adaptation to drought risk in Kenya (Schrieks et al., 2024) and residents' coping with flooding risk in Germany and France (Bubeck et al., 2018). Overall, in Kwon and Silva (2020)'s review of the 62 most used behavioural theories in the literature between 2000 and 2017, EUT and PMT are at the 41st and 33rd place, respectively, showcasing some application but not wide use in empirical studies.

EUT and PMT are selected as both contain elements of perceived severity and perceived probability of a risk occurring (Schrieks et al., 2024) which in this work are assumed to be correlated with adaptation (Van Der Pligt, 1998). Combining EUT and PMT also allows to disentangle economic and psychological drivers (Bubeck et al., 2018) behind actions taken to address PWM. Contrary to other social psychology or economic behavioural theories that can be used to assess agents' response such as Ajzen's (1991) Theory of Planned Behaviour (TPB) or the Rank Dependent Utility Theory, both EUT and PMT include perception of risk. Individually, PMT also assesses adaptation costs and perceived adaptation efficacy while EUT considers attitudes to risk (such as risk aversion) and time (Schrieks et al., 2024). Such aspects (costs, efficacy and perception of time) are important in explaining uptake of CE actions with respect to plastic waste examined in this study. In this work we frame plastic waste mismanagement (PWM) as a fact that requires an adaptation response from firms that both use plastics in their production and whose functions (e.g., procurement of raw materials, public's view of the firm and are impacted by PWM, etc.) are impacted by PWM. We do not focus on the drivers for such firm behaviour; past literature has, for example, suggested that a natural resource-based view (NRBV) of the firm (Hart, 1995) can explain actions as its pyramid structure aims to influence decision-making on resources and capabilities in the fields of clean technology for firms that depart from the classical extract-use-discard model (Hart and Dowell, 2011). Such studies tend to use behavioural theories such as TPB or the theory of reasoned action to explain behavioural and attitudinal drivers and antecedents to such behaviour (e.g., Chan et al., 2022; Islam et al., 2024; Adu-Gyamfi et al., 2023) while bypassing the influence of received risk and perceived effectiveness in addressing the issue of PWM. Given the relative novel framing of PWM as a threat requiring adaptation, behavioural theories such as RDUT or economic theories such as Prospect Theory (which expands on risk aversion found in EUT) that require agents providing weighting of probabilities of a threat occurring were not considered (Osberghaus, 2017).

Sub-Saharan countries are rapidly producing increased quantities of plastic waste, with 70 % of it reported to be openly dumped in 2019 which, in turn, constitutes a tangible health and economic risk (Ayeleru et al., 2020). There is a lack however of empirical work determining the impact of perceived risk in plastic waste (mis)management. Some country-level studies that have focused on plastic waste in sub-Saharan countries, such as Rwanda, found it lacking technically advanced practices that would enable both better plastic management and reduce imported plastics (Twagirayezu et al., 2024) while improved plastic waste collection and sorting was found to drastically decrease plastic waste flows to landfills for consecutive years in South Africa (Olatayo et al., 2024). This study focuses on one of the biggest current (and forecasted as increased in the future) contributors to plastic waste pollution in Africa, Nigeria.

2.1. Geographical focus and objectives

Nigeria is experiencing sustained population and urbanisation

growth with its largest population centres such as Lagos, Kano and Kaduna generating an average 0,55 kg/person/day of waste, with at least 20 % of it being plastic waste (Duru et al., 2019). Plastic waste is mainly related to consumer-produced plastic waste with single-use plastic sachet water bags being a considerable contributor to plastic waste accumulation. Over 60 million such water bags are bought and disposed daily in Nigeria (Dumbili and Henderson, 2020) and tend to accumulate since their introduction in the Nigerian market in the 1990s (Duru et al., 2019). Single-use plastics such as shopping bags and food/takeaway packages are also contributing significantly to plastic waste generation (Dumbili and Henderson, 2020; Duru et al., 2019). Lack of proper waste management, disposal and recycling is also contributing to Nigeria being the 9th largest contributor to marine plastic pollution globally (Dumbili and Henderson, 2020) both in terms of macro and microplastics (Yalwaji et al., 2022). Overall, Nigeria is one of the highest plastic polluter countries in Africa, only second to Egypt (Akan et al., 2021).

Nigerian authorities struggle to process waste, with urban centres reporting waste collection efficiency between 5 and 50 % (Ogwueleka, 2009) with lack of compliance monitoring and enforcement being named as the main barriers to increased efficiency (Duru et al., 2019). Lack of awareness across the population on the impact of plastic waste is widely reported in the literature, as is the need for reforms in political and social will to address the issue (e.g., Dumbili and Henderson, 2020; Oladipupo et al., 2024; Solaja et al., 2024; Zuofa et al., 2023). Given the prevalence of plastic waste and the issues around its mismanagement, framing plastic waste mismanagement (PWM) as a threat is therefore justified. The methodology chosen for the empirical investigation of the perceived effect and perceived effectiveness of firms to deal with PWM is described in the next sections.

2.2. Firm behaviour with respect to plastics in the Nigerian context

As consumers are driving plastic waste generation in Nigeria, documenting and examining their behaviour has received some interest in the literature. For example, a recent study amongst Nigerian students has identified the beneficial impact of increased awareness, encouragement and capacity building in developing skills towards the circular plastic economy (Okoya et al., 2025). A small-scale household survey in mid-western Nigeria found mostly unsustainable waste disposal practices (Oladipupo et al., 2024). Few studies such as Solaja et al. (2024) have examined views of individuals involved in managing plastic waste (in this case recycling workers) on topics around plastic management. When it comes to surveying plastic-using firms' decision-makers on the topic of circular economy practices and plastic waste management, scant evidence is available in the Nigerian context. For example, Adesua--Lincoln (2025) finds that increasing training and financial support to Nigerian small and medium enterprises (SMEs) can support engagement in sustainable practices. Through focus groups of individuals working in the construction sector Zuofa et al. (2023) report lack of knowledge and interest in circular economy and (again) limited government support for applying circular economy practices as barriers to implementation.

Reducing, reusing and recycling plastic materials in production and consumption processes, as well as increasing the use of recycled plastic materials align with the principles of CE and contributes to environmental sustainability (Blomsma and Brennan, 2017). The different actions available to Nigerian businesses to provide solutions adhering to CE practices are mostly unexamined in the academic literature. Studies examining the acceptance and use of CE practices involving plastics in other emerging economies have identified the use of refillable or reusable products (Marazzi et al., 2020; Sandhu et al., 2025) and even eliminating single use plastics in final products (Ferronato et al., 2024). Using locally sourced materials alongside recycling activities has been mentioned previously in a Nigerian context (Donuma et al., 2024) while other actions involve using biodegradable materials for packaging (Moshood et al., 2022). Working across the value chain to ensure adoption of CE actions is also advised, such as liaising with suppliers to encourage minimisation of plastic use (Chitaka et al., 2022) or to support suppliers reach or maintain sustainable standards (Lee, 2021). Finally, as adoption of CE actions to reduce plastic has been found to be rather costly across developing and developed countries (Murphy et al., 2022), this also expected to be a major driver of firm decisions around plastic waste management.

Most of the above studies frame plastic waste management in the context of advancing towards a CE but do not conceptualise plastic waste as an actor of change in firm behaviour. Therefore, we identify the following, specific gaps in the literature: first, empirically examining perceptions and actions regarding PWM from actors in plastic-specific sectors are particularly lacking and second, case studies in the sub-Saharan African context (i.e., Nigeria) amongst decision-makers are mostly absent. This work aims to examine the endogenous nature choices managers and decision-makers in Nigeria are faced with while contributing to the wider adaptation literature above. It does so by combining economic social psychology theories to explain uptake of CE actions aiming to reduce PWM while examining the endogenous relationship between perceived effect from and perceived effectiveness to address PWM.

3. Methods and data

Three distinct hypotheses are tested in this paper and presented next. The first two refer to the framing of plastic waste mismanagement and the multi-faceted risk it poses to small and medium enterprises through the lenses of the Expected Utility and Protection Motivation theories. The final hypothesis refers to the proposed endogenous relationship between perceived effect and perceived impact from such risk.

3.1. Research hypotheses

This paper investigates the relationships between perceived impact of plastic waste mismanagement (PWM) and actions taken to address plastic waste through the lenses of Expected Utility and Protection Motivation theories. This study assumes that the level of engagement in multiple actions against PWM is not random and instead depends on how firms perceive PWM (Kedzierski et al., 2020) as an element of risk to their operations. Theoretically, firms which perceive PWM as a serious issue would do more (i.e., self-select) to address it. We focus on perceived impact of PWM as compared with other firms, instead of self-perceived effect, as a more accurate representation of being affected by PWM (Pringle et al., 2023) which can be caused by observational peer learning (Bubeck et al., 2018). We ground concepts and their framing to EUT as perceived impact of PWM and include elements of risk aversion and time (Schrieks et al., 2024).

We then assess perceived effectiveness in addressing and perceived impact from PWM through a series of actions that firms might currently undertake (Loy et al., 2023). We categorise these actions into *production-related* (Sandhu et al., 2025), *supplier-related* (Donuma et al., 2024) and *investment-related* actions (Chitaka et al., 2022) and appear as so in the analysis. Additionally, unobservable factors might affect uptake of actions addressing PWM while perceived effectiveness in addressing and perceived impact from PWM are considered endogenous. Therefore, addressing this selectivity and endogeneity bias requires an appropriate empirical approach. Perceived effectiveness is framed through PMT as it assesses adaptation costs and perceived efficacy of actions already taken (Cummings et al., 2021) while perceived impact from PWM is assessed through EUT. To examine the combined effect of perceived impact and perceived effectiveness, this study uses a Heckman sample selection model (Heckman, 1976) and accounts for any issues around homoscedasticity and independence of errors by the use of robust standard errors in the analysis. Such a model assists with determining the size of the impact of an endogenous, unobserved variable (such as perceived impact of PWM) on observed ones (such as preparatory actions

involving internal and external factors in a firm).

The methodological approach therefore is applied through two equations: the selection equation (Eq. (1)) where the firms that perceive PWM as a risk to their operation are identified and then the outcome equation (Eq. (2)) which assesses observed effectiveness in managing plastic waste in the selected firms as well as the impact on perceived effectiveness of firm actions and characteristics. Each binary variable (perceived impact PWM and effectiveness in dealing with PWM) is regressed on a series of covariates. Therefore, for firm i

$$Affected\_PWM_i = \alpha + \alpha_1 ExpIssues_i + \alpha_2 LoanAccess_i + \alpha_3 ForegoPresent_i + u_i \quad \text{(Eq.1)}$$

and for firm i and firm actions j

$$Effective\_PWM_{ij} = \beta + \beta_1 Strategy_{ij} + \beta_2 Supply_{ij} + \beta_3 Invest_{ij} + \beta_4 Cost_{ij} + \varepsilon_{ij} \quad \text{(Eq.2)}$$

with u_i and ε_{ij} being the error terms.

The selection, outcome equation and their covariates are presented in a hypothesis form below.

H1. Higher perceived impact of plastic waste mismanagement is positively associated with the following factors (this is the selection equation using constructs influenced by the Expected Utility Theory):

- H1a: Higher perceived effectiveness in addressing plastic waste mismanagement compared to other companies (Pringle et al., 2023).
- H1b: Greater ease of access to funding for managing plastic waste (Zuofa et al., 2023).
- H1c: A greater willingness to forego immediate benefits in favour of larger future gains (Schrieks et al., 2024).

H2. Effectiveness in reducing plastic waste depends on a) actions involving new technology (Marazzi et al., 2020; Ferronato et al., 2024), b) engagement with suppliers (Moshood et al., 2022), c) investments around adopting circular economy strategies (Chitaka et al., 2022) as well as d) ease of funding access to tackle plastic waste mismanagement (Zuofa et al., 2023). This is the outcome equation with constructs influenced by the Protection Motivation Theory.

H3. Being effective in plastic waste management (H2) is associated with the perceived effect of plastic waste mis-management (H1).

These three hypotheses are tested using regression analysis which accounts for the potential endogenous relationship between the dependent variables in both H1 and H2 (i.e., being affected by plastic waste mismanagement and effectiveness in reducing plastic waste). The data used and results produced are described in the next section.

3.2. Data collection

Data were collected between December 2024 and February 2025 from managers in Nigerian small and medium enterprises (SMEs) as part of a wider survey aiming to understand different aspects of the circular economy in the country, through a variety of means. There are approximately 39 million micro, small and medium businesses (MSMEs) as of 2020 in Nigeria, but no official registry exists of circular businesses (Ochigbo, 2025)while only 3.1 million businesses are officially registered. Therefore, in this study, sampling was conducting using the authors' personal networks in the country and leveraging online communities with a stated interest in CE.

First, businesses located in the states of Kano, Oyo, Abuja and Lagos which traditionally have the highest number of registered of micro-enterprises (National Bureau, 2013) were targeted. Using industry directories, business networks, and referrals, direct messages and calls were made to encourage stakeholders to complete the questionnaire. Around 20 % of responses came through these endeavours. The rest of the responses were collected through messages sent via a digital platform (WhatsApp), a widely used communication platform in Nigeria. Several CE-focused WhatsApp groups were identified, and permission was obtained from group administrators to share the survey link. These groups included the Recycling Association of Nigeria (RAN) with 328 members, the Circular Economy Business Network managed by the Office of the Special Adviser on Climate Change & Circular Economy (OCCE with 517 members, the African Clean-Up Initiative with 276 members and the Sustainable Solutions Circle with 147 members. Such groups were particularly (but not exclusively) targeted during data collection, as they operate in areas crucial to a CE transition, such as e-waste recovery, construction, plastic recycling and the processing of agricultural waste. A small incentive of a 1000 Naira mobile recharge card was given to those who finished the survey. This resulted in 260 total questionnaires returned, and when removing incomplete responses this resulted in 251 useable responses. When removing speeders (those taking less than 3 times the median time to complete the survey), this resulted in 242 complete responses, and these were used in the analysis in Section 4.2. The median time of completion was 17.6 min, and most responses came from middle managers from the more densely populated as well as industrial and entrepreneurial areas of the country, as depicted in Fig. 1 below.

The questionnaire developed for this study and its sections refer to the firm's composition (such as number of employees, turnover, etc.), the respondent's role in the organisation (upper, middle management, etc.) and contained sections on the use of new technologies and organisational paradigms not covered in this study. The final section of the survey focused on perceptions and views on plastic waste management in the respondent's firm, and this data is used below, alongside that on firm composition. Statements on EUT and PMT were adapted from Schrieks et al. (2024) to reflect the PWM scope. The summary statistics of that section can be found in Table 1. Summary statistics on the sample surveyed, by managerial level (junior, middle and senior), can be found in the Supplementary Material.

4. Results and discussion

The following subsections present both summary statistics and the data-driven investigation of the relationships between perceived impact of plastic waste mismanagement (PWM) and actions taken to address plastic waste through the lenses of Expected Utility and Protection Motivation theories. As prior information on firm behaviour regarding plastic waste management in Nigeria is scant, Section 4.1 discusses the summary statistics in length before the presentation of the hypotheses testing through a sample selection model in Section 4.2. The summary statistics presented in Table 1 are also presented visually in Figs. 2–4. Fig. 2 presents the uptake of CE actions; Fig. 3 presents the frequencies of uptake of supplier-focused CE actions and Fig. 4 presents the frequencies of investment actions related to CE.

4.1. Summary statistics

Most responses came from the coastal southwest areas and in and around Lagos where most small businesses are located. Overall, findings in Table 1 report actions towards a circular economy to be in their infancy in Nigeria while plastic waste mismanagement (PWM) seems to affect a small but considerable number of firms. Such findings are in line with other studies reporting low levels of plastic waste awareness in Nigeria (Duru et al., 2019; Oladipupo et al., 2024) as well as low uptake of actions towards the circular economy (e.g., Dumbili and Henderson, 2020; Akan et al., 2021; Zuofa et al., 2023).

As shown in Fig. 2, almost half (50 %) of surveyed Nigerian firms claim to use reusable or refillable packaging in their products which has been one of the earliest consumer-facing interventions. This is somewhat

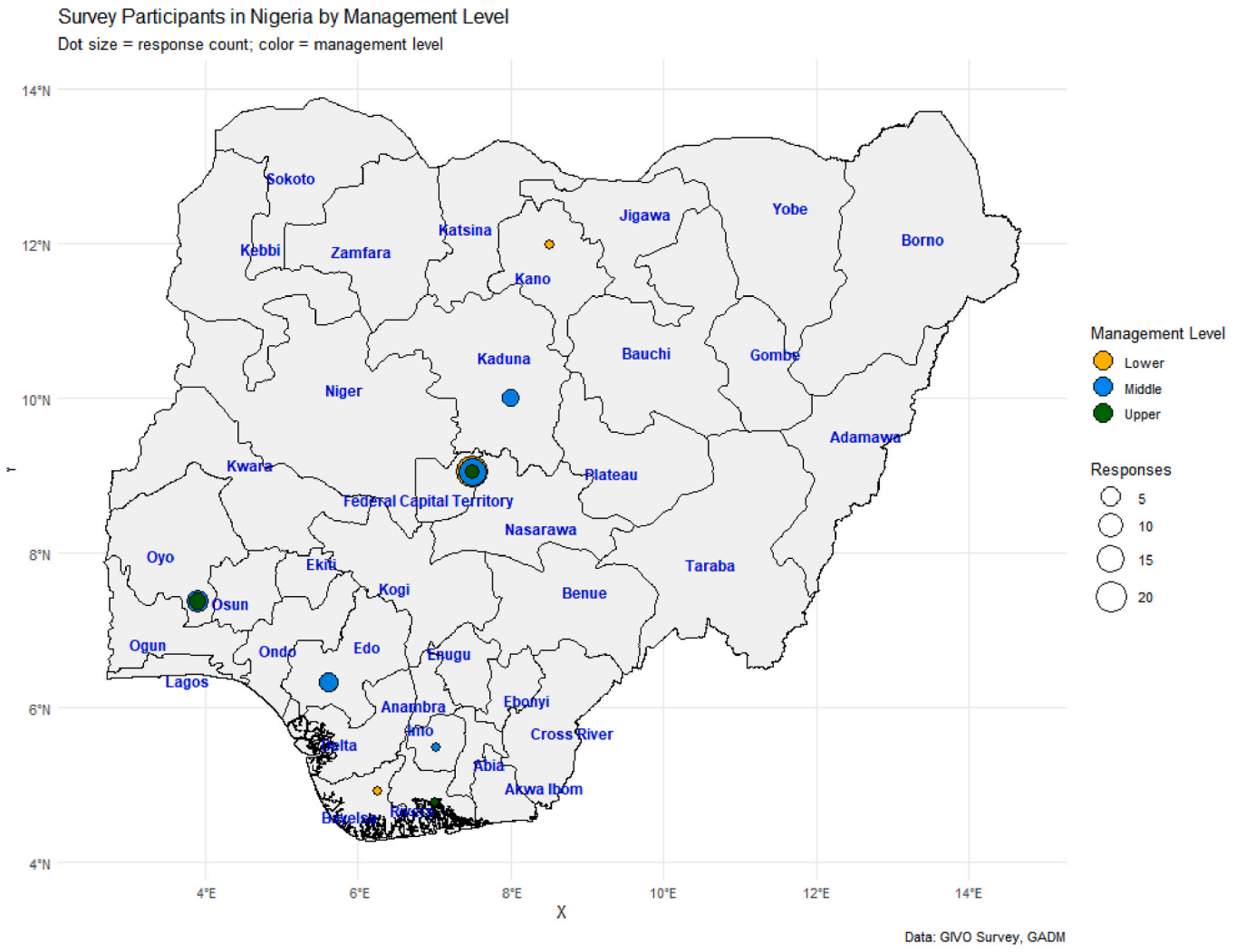

Fig. 1. Locations of main survey data collection points in Nigeria, by management level.

expected given both the high number of RAN-affiliated SMEs in the sample and the high reported levels of such plastic waste across the country (Duru et al., 2019) and could signal attempts to present one's firm as 'green' or 'eco-friendly'. Nevertheless, only a small number of firms claim to not be implementing any CE actions (7 %). Such a percentage is similar of the number of European SMEs not implementing CE actions (Bassi and Dias, 2019). Empirical and theoretical studies abound examining the drivers for such behaviour (Kim and Lyon, 2015; Marquis et al., 2016; Cantore, 2017) while considerable focus has been given to antecedents and frameworks of firms inaccurately introducing green or eco-labels to either themselves or their products (Arouri et al., 2021). Such high levels of reported actions might also reflect the recent increase in initiatives around plastic waste management and disposal in Nigeria such as the recent United Nations Industrial Development Organisation (UNIDO)'s 1.9 USD million funded project to promote sustainable value chains and circular economy practices (Onaji-Benson and Agada Ali, 2023) and the Plastic Recycling France Nigeria project aiming to provide technical assistance and training towards installing two recycling microfactories by 2025 (Plastic Odyssey, 2024).

More cost-driven and production-paradigm altering solutions such as eliminating single use plastics or sourcing local biodegradable materials are much less commonly employed. Focusing on the supply chain, firms seem to prefer to focus on solutions that have small economic imprint on their operations such as encouraging suppliers to use recycled or eco-friendly materials (46 %, see Fig. 3) while much fewer firms claim to switch materials or partnerships in pursuit of more eco-friendly materials. Concern over costs to adopt CE practices is common among stakeholders in large economies as well (e.g., McNicholas and Cotton, 2019). Such a finding can be explained by the lack of funding, or awareness of funding reported in the country in other studies (Zuofa et al., 2023) but it appears also linked with the lack of awareness on the PWM issue (Duru et al., 2019; Oladipupo et al., 2024). This trend also appears when asking firms about their investments (see Fig. 4); 32 % of firms claim they do not invest on any of the listed circular economy-related actions. Some investments in locally sourced, biodegradable materials are observed which can also be related to traditional ways of producing and distributing goods such as foodstuff in the country.

Responses regarding the assumed cost of PWM (see bottom of Table 1) become of interest when contrasted with total firm turnover. 26 % of respondents claimed that their firm has an annual turnover more than 18 million Naira, yet the mean stated cost for reducing single use plastics (*Cost_reduce*) is assumed to be 18,8 million Naira making PWM costs considerably high for all turnover bands. Several responses claimed that such a cost would be zero (8 %, 6 % and 9 % for *Cost_reduce, Cost_engage* and *Cost_invest*, respectively) which is not realistic. Nevertheless, this study reports the raw findings of the expected cost of dealing with PWM and the responses by the survey participants correspond to the increased commitment required by each action, therefore, can reflect actual information the participants possess. In any case,

Table 1
Summary statistics of binary variables representing elements of EUT and PMT; * refers to a Likert-scale variable taking the values 1 to 5 and its mean value (standard deviation in brackets); ** refers to 226 observations after removing values below 100 RGN but not 0 values; values reported in 1000 RGN.

Variables	Description	Observations	Frequency	Behavioural Theory
Affected_PWM_high	Often/very often expect issues with PWM	243	17 %	EUT, PMT
Expected_ issues_PWM_high	Often/very often issues with PWM compared to others	243	13 %	EUT
Loan_access_high	Very/Extremely adequate access to loans	243	12 %	EUT
Foregoing_present_high	Willing/very willing to forego present benefits for future ones	243	54 %	EUT
Effective_PWM	Effective/very effective in achieving PWM goals	243	31 %	PMT
No_single_use	Eliminating single-use plastics in operations	243	19 %	PMT
Reusable_alts	Offering reuseable of refillable alternatives	243	50 %	PMT
Biodegr_compost	Switching to locally available biodegradable or compostable materials	243	9 %	PMT
Local_partnerships	Partnering with local artisans or organisations to repurpose plastic waste	243	15 %	PMT
No_above_actions	No PWM reduction actions	243	7 %	PMT
Supply_recycle	Encouraging suppliers to use recycled or eco-friendly materials	243	46 %	PMT
Supply_standards	Sourcing from suppliers who meet local and international sustainability standards	243	29 %	PMT
Supply_altpack_solutions	Partnering with local manufactures to develop alternative packaging solutions	243	14 %	PMT
No_above_actions	No supplier-driven PWM actions	243	15 %	PMT
Invest_biodegr	Locally produced biodegradable or plant-based materials	243	32 %	PMT
Invest_cardboard	Paper or cardboard packaging sourced from Nigerian suppliers	243	28 %	PMT
Invest_local_material	Other locally sourced alternatives (e.g. cassava-based plastics)	243	8 %	PMT
No_above_actions	No investment actions for PWM	243	32 %	PMT
*Income_1**	Above 18,000,000	231	26 %	EUT,PMT
*Income_2**	Between 12,000,000 and 18,000,000	231	23 %	EUT,PMT
*Income_3**	Between 6,000,000 and 1,000,000	231	26 %	EUT,PMT
*Income_4**	Below 1,000,000	231	26 %	EUT,PMT

Cost-related variables (cont)*		**Mean**	**St.Dev**	**Min/Max**
Cost_reduce	Can you give an estimate of the cost, in Naira (₦), for your organisation to - Reduce single-use plastics	158,000	1,600,000	0/ 18,000,000
Cost_engage	Can you give an estimate of the cost, Naira (₦), for your organisation to - Engage with suppliers so that plastic waste is reduced	299,000	3490000	0/ 50,000,000
Cost_invest	Can you give an estimate of the cost, Naira (₦), for your organisation to - Invest in alternative materials to replace traditional plastics	487,000	6,080,000	0/ 90,000,000

participants seem to consider such costs to be high to very high, between 80 % and 270 % percent above the highest category of stated annual turnover for a firm (18 million Naira). As Nigerian SMEs have been found to operate with very low or even negative profit margins (Toby, 2007), expecting such comparatively large investments to address might not be feasible for surveyed firms. Given the lack of awareness around PWM (Duru et al., 2019), knowledge of such potential costs might also be scarce (as can be seen from the large standard deviation for each of these three variables) and therefore such estimates should be cautiously interpreted. Most of the sample is split between the other three annual turnover categories, classifying most firms as small to medium enterprises.

Regarding the perceived effect of PWM and the perceived effectiveness of firms to address PWM (see top of Table 1), more firms claim to be effective in addressing PWM (*Effective_PWM* = 32 %) than firms claiming to be highly or very highly impacted by PWM (*Affected_PWM_high* = 13 %). Even fewer firms (*Expected_ issues_PWM_high* = 17 %) expect issues often in their production or supply functions to be affected by PWM while a surprising percentage (*Foregoing_present_high* = 54 %) places a higher value in future benefits compared to present ones.

4.2. Relationship between perceived impact and effectiveness

The results of the assumed endogenous relationship between effectiveness in PWM and perceived effect of PWM through a Heckman two step model are presented in Table 2 below. The results of the selection equation are presented in the top of the table with the results of the outcome equation at the middle and bottom of the table. Only the cost to reduce single-use plastics is included in the outcome equation as it appears both as the most conservative of all three cost-related variables. Additionally, given the disparities described in section 4.1 between annual turnover and expected cost of addressing different types of plastic waste (single use plastics, engage with suppliers and invest in alternative materials), including one cost-related variable to abide with PMT prevents high correlation between cost-related covariates. The variable indicating greater ease of access to funding for managing plastic waste (*Loan_access_high*) appears in both equations, as required by the sample selection approach (Chatzistamoulou and Tyllianakis, 2022). The stepwise approach described later in this section indicated that including income variables and cost-variables resulted in implausibly high correlation between the error terms; cost estimates were available only from 222 participants and this further reduces the sample of the outcome equation. A small number of firms perceived PWM as a considerable threat to their business leading to a low number of responses (42) included in the outcome equation. This affects statistical significance of variables in the outcome equation and therefore the testing of H2.

The Wald Chi^2 test (at the bottom of Table 2) is statistically significant below the 5 % level meaning that the covariates in both equations cannot be simultaneously equal to zero giving credence to the use of the sample selection approach. All variables in the selection equation apart from access to loans are significant at the 1 % level and have a positive impact on the perceived effect of PWM This means that H1, which was framed with Expected Utility Theory (EUT) elements, cannot be rejected in its entirety. In detail, we find that higher perceived effectiveness in addressing PWM when compared with other similar firms (H1a) and placing higher value on future than current wealth (H1c) all statistically and positively impact perceived impact from PWM. Schrieks et al. (2024)'s study on drought risk adaptation in rural Kenya also reports EUT having the best fit in their data for their regression analysis. Expected perceived impact of PWM is influenced by likelihood of high perceived impact by PWM compared to peer firms. Self-knowledge and

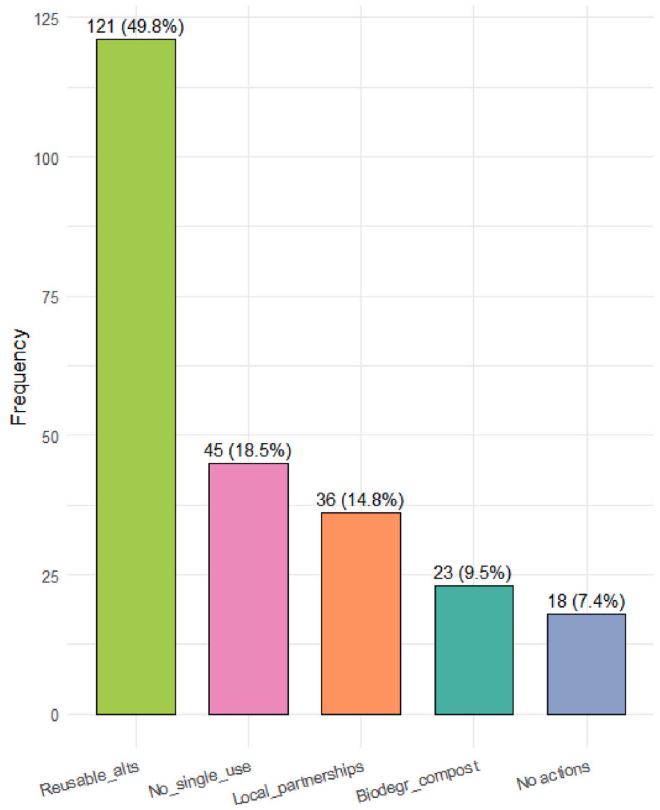

Fig. 2. Frequencies of uptake of CE actions according to Nigerian SMEs decision-makers.

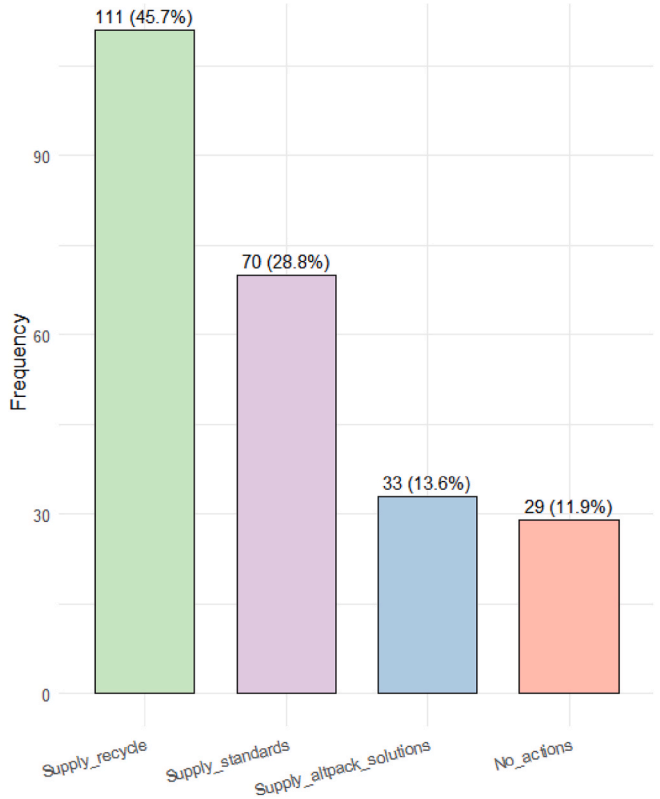

Fig. 3. Frequencies of uptake of supplier-focused CE actions according to Nigerian SMEs decision-makers.

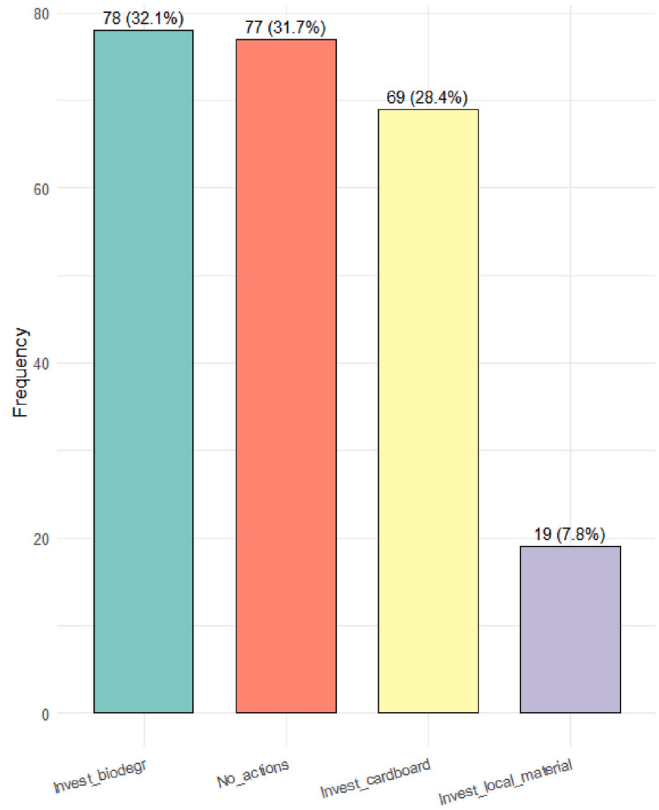

Fig. 4. Frequencies of investment actions related to CE according to Nigerian SMEs decision-makers.

Table 2
Results of the Heckman two-step model on the endogenous relationship between expected impact of plastic mismanagement and perceived effectiveness in reducing plastic waste. ***, ** indicate statistical significance at the 1 % and 5 % levels, respectively.

Selection Equation: *Affected_PWM*	Coefficient	St. error	Behavioural theory/ Hypothesis
Expected_ issues_PWM_high	0.756***	0.252	EUT, PMT/H1
Loan_access_high	0.422	0.272	EUT, PMT/H1
Foregoing_present_high	0.597***	0.215	EUT/H1
Constant	−1.509***	0.184	n/a
Outcome Equation: *Effective_PWM_high*			
No_single_use	0.648	0.629	PMT/H2
Reusable_alts	−0.153	0.607	PMT/H2
Biodegr_compost	−0.652	1.466	PMT/H2
Local_partnerships	0.521	0.671	PMT/H2
Supply_recycle	1.253***	0.486	PMT/H2
Supply_standards	0.644	0.606	PMT/H2
Supply_altpack_solutions	0.751	0.839	PMT/H2
Invest_biodegr	−0.263	0.447	PMT/H2
Invest_cardboard	−1.237**	0.556	PMT/H2
Invest_local_material	−0.684	0.591	PMT/H2
Cost_reduce	<0.001	<0.001	PMT/H2
Loan_access_high	0.687	0.585	EUT, PMT/H2
Constant	3.896***	1.167	n/a
Inverse Mills ratio	−1.209*	0.675	
Rho	−0.848		
Sigma	1.426		
Observations	242 (selection = 42)		
Wald Chi^2 (12)	23.12**		

perceptions of risk are more difficult to assess (Pringle et al., 2023) and therefore it follows that they are dependent on the relative position of peer firms with respect to PWM. Other studies have corroborated that

observational or peer learning can improve risk-related adaptation actions (Bubeck et al., 2018). Finally, those who assign more value in the future compared to the present are more likely to perceive being more affected by PWM which can lead to higher likelihood to adapt to PWM, similar to other studies (e.g., Schrieks et al., 2024).

Few variables in the outcome equation are statistically significant, offering little support to H2 and its framing using PMT. As PMT requires multiple elements (actions, perception of risk and associated costs), the stepwise approach revealed that the outcome equation results presented in Table 2 tend to be similar in terms of statistical significance even as more variables were gradually added. Overall, only two coefficients out of the three different types of actions (supplier-related and investment-related) were statistically significant. In detail, supplier-related actions that a firm might employ, the most frequently selected (and probably cost-free) action of encouraging suppliers to use recycled or eco-friendly materials (46 % of the sample, see Table 1) increases the likelihood of a firm's (self) perceived effectiveness in dealing with PWM.

It is noteworthy that the framing of the statement in the questionnaire is around *encouraging* suppliers and not *requiring* suppliers to abide by circular economy principles. Supply chain initiatives undertaken jointly by suppliers and distributers has been shown to increased adoption of eco-friendly standards (Jayaram and Avittathur, 2015). In a similar vein, a firm's investment on biodegradable materials such as paper or carboard or natural materials such as pulp instead of plastic packaging also positively affects the probability of perceived effectiveness in dealing with PWM (Resnitzky et al., 2021; Singh et al., 2023).

Overall, both these actions (encouraging suppliers to use recycled or eco-friendly materials and using paper or cardboard packaging sourced from Nigerian suppliers) appear as low-effort and locally-sourced (e.g., using Nigerian suppliers is a requirement in the *Invest_cardboard* option) which can be linked to limited funding and awareness on the impact of PWM might make explain uptake of such actions.

Finally, the inverse Mills ratio is significant and negative, matching the negative correlation coefficient (rho = −0.85) meaning that perceived effectiveness in plastic waste management (*Effective_PWM*) and perceived effect of PWM (*Affected_PWM_high*) have an endogenous relationship, supporting H3. This result indicates that the sample selection approach is appropriate (Tyllianakis et al., 2024). The correlation coefficient (rho) which measures the error term in the outcome equation and the error term in the selection equation is close to −1 which although numerically plausible requires caution when interpreting results. The small selection sample (42 respondents) can make rho very sensitive therefore the model presented in Table 2 was computed with a stepwise approach gradually adding covariates in the outcome equation and presents the best fit to the data that minimises rho. Finally, the negative correlation sign might be an indication of the risk perception paradox (Wachinger et al., 2013) which would mean that those firms that are highly effective in dealing with PWM are also simultaneously less concerned about its impact.

This study contributes to the small but growing evidence base of perceptions towards plastic waste management and the risk mismanagement of such plastics presents to firms. Adaptation decisions in response to risk, both as individual and communal, are shown in this study to be correlated with self-efficacy in adaptation (dealing with PWM). Such a finding corresponds with studies on drought adaptation finding perceived adaptation efficacy and self-efficacy in specific adaptation measures to be more important in promoting specific adaptation measures (Schrieks et al., 2024). Additionally, risk appraisal has a positive effect in actions taken to address PWM, similar to responses of farmers to climate change threats (Mitter et al., 2019) and houseowners faced with flooding risk (Bubeck et al., 2018).

The statistically significant findings in the selection equation and the support they offer towards H1 mirror findings from other studies in Nigeria focusing on consumer views and behaviour. The common thread with the firm-focused study presented here and studies conducted in Nigeria such as Okoya et al. (2025) and Solaja et al. (2024) is the need for raising awareness as perceived risk from PWM is not comparable with the high pollution rates reported in other studies (Dumbili and Henderson, 2020; Yalwaji et al., 2022; Akan et al., 2021). Another of the salient findings of this study is the importance of access to funding to address PWM both in the outcome and selection equations. In other words, higher perceived access to such funding makes people both more concerned about PWM and more competent to address it. This corroborates findings in Nigeria amongst small and medium enterprises that report lack of financial support as a main barrier to implementing circular economy actions (Adesua-Lincoln, 2025; Zuofa et al., 2023).

Although PWM can have a financial impact on firms, this is more likely in the contexts of firms operating in environments with more stringent laws or where access to funding is predicated on meeting several environmental and operation standards. For example, ISO 14021 requires firms to follow certain guidelines when it comes to them making environmental assertions, and in the case of some countries, fines ensue in case of violations (Delmas and Burbano, 2011). Given the relative size of expected costs to deal with PWM (reported in Table 1 in Section 4.1), it follows that access to, and knowledge of such funding streams emerges as a key determinant of actions. Therefore, our study connects awareness of risk (in our context, PWM) and awareness of coping strategies (or tools to achieve them, through access to funding sources). Such a finding is reported elsewhere in the risk adaptation literature (e.g., Tyllianakis et al., 2024) although it is also common for individuals to over- or under-estimate their ability to adapt to threats (Elrick-Barr et al., 2017).

Limitations of this study centre around the baseline of stated adoption of CE practices across firms and the framing of the hypotheses which followed two different behavioural theories (EUT and PMT) but did not include all elements from each theory in the models presented in Table 2. There is little to no information on the progress and maturity of circular economy practices in Nigeria or Africa; for example, developing and implementing a framework that measures the circularity of a firm's operations and then compares it with peer firms is suggested by Bandeira et al. (2025). Although expenditure for addressing PWM after the PMT was included, this was framed as expected adaptation cost and therefore does not represent actual expenditure. Aversion to risk was also not quantified or used in the EUT making testing both theories incomplete. The chosen methodology assumes an endogenous relationship between perceived impact and perceived effectiveness, and this was confirmed through the analysis; nevertheless, the decision-making process and the antecedents to perceived risk and the mediating effects of firm-related variables on perceived effectiveness were not analysed. Such analyses would require structural equation modelling techniques that are also able to confirm the validity of constructs that rely on behavioural theories such as those employed in this study, but this was beyond the scope of this paper. Future studies in similar socio-economic and geographical contexts could employ a mix of regression analysis to explain variation in key variables as well as structural models to test behavioural model validity. Finally, we did not differentiate the analysis based on the level of management respondents belong to (upper, middle or low) as this would segment our sample in too small sub-samples; it is possible that knowledge of actions and perceived effectiveness and effect from PWM to be higher in those in higher management as they bear bigger responsibilities and have better grasp of a firm's policies.

5. Conclusions and managerial recommendations

This study examines firm behaviour in terms of adopting circular economy practices which are particularly aimed at addressing mismanagement of plastic waste. Plastic waste is therefore conceptualised as an element of risk to both firms, the environment and society which, in turn, requires adaptation to. Such risk is then approximated and analysed using two different behaviour theories, one economic (Expected Utility Theory, EUT) and a social psychology one

(Protection Motivation Theory, PMT). Using a survey amongst decision-makers in Nigerian small and medium enterprises (SMEs), this study aims to fill in the knowledge gap of plastic waste management and perceived risk and perceived effectiveness in addressing it. Understanding perceived risk and decision-making under such risk is paramount in both understanding firm behaviour and explaining current and future uptake of circular economy actions in developing countries with high population growth such as Nigeria.

Decision-makers in surveyed Nigerian SMEs appear to have low to moderate levels of perceived impact of plastic waste mismanagement (PWM), as well as perceived effectiveness in addressing PWM. Although this finding is not surprising, it is indicative of an overall lack of a societal step-change in the direction of a circular economy. Nigerian firms seem to uptake low-cost and low-effort solutions to PWM, while solutions that require bigger investments in the production or supply chain are much less common. This is further confirmed in this study by examining the endogenous relationship between perceived impact of PWM and perceived effectiveness in dealing with it. The expected cost of addressing PWM, either by reducing single use plastics or making more long-term commitments such as changing the supply chain and invest in alternative materials seems to be perceived as too high for Nigerian firms surveyed. Policymakers and managers alike should therefore focus on information and education campaigns within firms regarding the true costs to a production and economy model of a CE.

Findings indicate that perceived risk from PWM is well-conceptualised by Nigerian firms and is impacted by factors such as perceptions of other firms' effectiveness to deal with PWM, access to funding to deal with PWM and by foregoing present benefits in favour of future ones (because of dealing with PWM). Even though survey participants do perceive PWM as a risk to their business, this does not necessarily drive effective management of plastic waste, although the two concepts are correlated. Perceived effectiveness in dealing with plastic waste does not equate to actual effectiveness; nevertheless, it appears to be driven by low-cost, low effort solutions such as encouraging suppliers to provide recyclable materials and packaging and investing in paper and cardboard packaging. Availability of and access to loans to deal with PWM was found to have a positive effect both on perceiving impact of PWM and on perceived effectiveness in addressing it. Therefore, this study echoes previous ones in advocating for improved and frictionless access to funding for firms to accelerate a CE transition.

This study provides statistical evidence for the conceptualisation of PWM as risk to businesses through the EUT. EUT includes perceived severity and perceived probability of a risk occurring as well as perception of and attitudes towards risk (such as risk aversion) and time. This study therefore presents evidence towards PWM being conceptualised as a tangible risk to business operations by Nigerian decision-makers. Although this study conceptualises PWM as a risk to businesses, it did not specify what type of risk it might constitute for them. As businesses can be driven by utility-maximising behaviour (the theoretical framework for EUT), securing profits and operational surpluses might be driving behaviour. This appears to be the case in this study, with perceived costs of addressing PWM being as high or higher than the average annual turnover of a firm. Therefore, managers should focus on creating the conditions for firms to comply to environmental regulations, as well as educational and promotional campaigns. Lack of know-how, lack of awareness of the magnitude of PWM on both ecosystems and humans could also incentivise actions against PWM, as well as creating a paradigm-shift in how circular economy and its principles are perceived in developing countries.

CRediT authorship contribution statement

Emmanouil Tyllianakis: Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Oluwaseun Kolade:** Writing – original draft, Conceptualization. **Ambisisi Ambituuni:** Writing – original draft, Conceptualization. **Olawunmi Ogunde:** Writing – original draft, Data curation. **Muyiwa Oyinlola:** Writing – original draft, Conceptualization. **Soroush Abolfathi:** Writing – original draft, Funding acquisition.

Declaration of competing interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2025.147086.

Data availability

The data that has been used is confidential.

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