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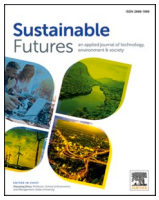

Driving voluntary reduction of single-use plastic consumption: Capability, opportunity, and motivation

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ABSTRACT

The excessive use of single-use plastic (SUP), especially SUP tableware, has caused a global plastic waste crisis. Understanding the factors that drive consumers to reduce SUP tableware usage is essential for addressing this issue. Current studies often use simplistic models that fail to capture the complexity of human behavior in reducing SUP, indicating a need for more comprehensive approaches. Grounded in the robust COM-B model and the Theoretical Domains Framework (TDF), this study aims to understand the factors influencing individuals' behavior to reduce SUP tableware. These frameworks offer a solid basis for our research, viewing complex SUP consumption behavior as an interplay of capability (psychological and physical), opportunity (social and environmental support), motivation (people's thinking and feeling), and outcome behavior. Two online surveys were administered to 354 (Study 1) and 644 (Study 2) Chinese participants. Results showed that capability and opportunity are associated with SUP tableware reduction behavior, fully mediated by motivation. The model explains 70 % of motivation in SUP tableware reduction. Motivation predicts approximately 48 % of actual SUP tableware reduction behavior. Capability, opportunity, and motivation are higher-order constructs measured by lower-order constructs. Capability is predicted by action control, action planning, action skills, decision-making, and habits. Behavioral Opportunity is associated with social norms, social support, and environment. Motivation is affected by identity, reinforcement, goals, and self-efficacy. Finally, theoretical and practical contributions inspiring more consumers to protect our environment were discussed.

1. Introduction

Plastic provides a cheap and convenient option for us to live a fast-paced life. With increasing consumer and food supply chain demand, plastic production continues to grow, with forecasts indicating that single-use plastic (SUP) will double by 2030 [1]. Current SUP usage rates have already caused a plastic waste crisis. Modelling indicates that ocean plastic garbage will outnumber fish by 2050 [2]. SUP represents one-third of plastics produced and contribute to most plastic waste disposed of in landfills or directly into the environment [3].

SUP tableware, such as straws, stirrers, forks, knives, spoons, cups and their lids, bowls, plates, food containers and their covers, consumed and disposed of during and after the pandemic reached new heights along with the surge in takeaway orders and food safety concerns rising. The food industry remains the largest user of SUP [4]. SUP tableware, which is used by consumers for one meal or drink but takes >400 years to decompose, was the top ocean garbage, constituting 15.5 % of all waste items found in the world's oceans [5]. Thus, urgent action is needed to mitigate the plastic crisis by voluntarily reducing demand for SUP tableware.

Governments and environmental protection organizations have attempted to reduce SUP in response to the plastic waste crisis that has gained media and advocacy attention, demonstrating the damage already delivered by SUP in land-based and marine ecosystems. Government policy to ban or impose levies on plastics has dominated response efforts thus far, with few voluntary approaches evident. Engaging citizens to care can be challenging when immediate and proximal individual interests such as speed and convenience outweigh

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ill-defined consequences that are only realized in the future [6]. Although consumers are greener in purchase and consumption choices, their overreliance on SUP may be difficult to change if the plastic waste problem is out of the sight and mind of individuals. Reducing SUP tableware is a challenge in modernized cities featuring fast-paced consumer lifestyles prioritizing price and convenience over slower, more expensive, sustainable consumption approaches. Plastic is an inexpensive part of our everyday lives. The persistent, irreversible, and omnipresent nature of plastics in the environment [7] calls for a readjustment of how people use SUP. Although green purchase behavior in the context of plastic reduction has been extensively studied, the attitude-behavior gap still exists in consumers' daily consumption, halting the progress of plastic waste reduction [8].

While we face a pressing need to motivate individuals' voluntary SUP reduction behaviors, many popular behavior change theories are too simplistic [9] as they do not account for the complexity of plastic waste reduction. Many theories overlook the many known influences on SUP, directing researcher attention to rational drivers (e.g., Theory of Planned Behavior (TPB), Theory of Reasoned Action (TRA)) or social drivers (e.g., Social Norms theory). To better understand, predict, and modify any environmental/cooperative behavior, we first need to focus on people and their environment. Many theoretical frameworks suggest focusing our attention on understanding how humans think, feel, and act. A common feature of these frameworks is to investigate whether people have the skills and ability to perform the desired behavior [10]. Yet, other frameworks challenge researchers to also consider whether individuals have the opportunity to perform a desired behavior [11]. Building upon popular behavioral models such as the Theory of Planned Behavior, Health Belief Model, Social Cognitive Theory, Protection Motivation Theory, Self-Determination Theory, and the Transtheoretical model, a meta-analytic study by Michie, et al. [12] showed that the Capability-Opportunity-Motivation-Behavior (COM-B) model could explain about 40 % of the variance in behavior. However, standardized measurement models to capture the components of the COM-B model are limited [13]. Most studies report COM-B applications restricted to qualitative inquiries. Therefore, this study aims to fill the research gap by developing a comprehensive framework to understand and address the discrepancy between consumers' attitudes and behaviours towards reducing SUP in their daily consumption. This study validates the utility of the COM-B model as a framework to assess how people think and feel (**M**otivation) and to determine the levels of personal, social, and environmental support (**C**apability and **O**pportunity) accessible to them to curb SUP tableware consumption (**B**ehavior). This study will outline the psychological and behavioral factors that motivate individuals to voluntarily reduce SUP for scholars, practitioners, and policymakers to formulate effective plastic waste reduction interventions.

2. Theoretical framework and hypothesis development

The **COM-B** model views behavior as part of a system of interacting factors [12].

Capability is the basis for an individual's psychological and physical capacity to do the behavior [12]. Previous research revealed that capability is strongly associated with motivation and behavior in a variety of contexts, including the purchase of airline tickets [14], virtual co-creation in new product development [15], electronic word-of-mouth [16], sedentary behavior [17] and physical activity [13]. Capability is divided into two sub-categories: psychological capability and physical capability. Psychological capability refers to intellectual capacity, decision-making, habits, action planning, and control to perform the behavior.

As outlined in the Theoretical Domains Framework (TDF) [18], psychological capability includes the domains 'knowledge', 'memory, attention and decision processes' (decision-making), and 'behavioral regulation' (action control (AC), action planning (AP) and habits (HA)). Knowledge is an essential precursor to reducing SUP [19], exemplified by work from Abdullah, et al. [20], Charitou, et al. [21] and Garcia-Vazquez and Garcia-Ael [22]. Likewise, memory, attention, and decision processes (decision-making) contribute to an individual's psychological capability to engage in SUP reduction behavior. A higher perception of a moral obligation when deciding to act environmentally friendly has been shown to increase the likelihood of pro-environmental behavior [23]. The indicators of action control, action planning, and habits, which are sub-categories of the TDF domain behavioral regulation, add to an individual's psychological capability to perform desirable SUP reduction behaviors. Action control, for instance, is a vital element of goal-directed behaviors, as demonstrated in the context of health behavior [24]. In a similar vein, action planning, for example, in the form of implementation intentions [25], feed into the behavioral regulation of individuals. Thinking about what steps individuals will take (i.e., action planning) to engage in a pro-environmental action has revealed a higher likelihood of going beyond intention [26]. In other words, individuals are more likely to engage in pro-environmental behavior if they are not only asked whether they intend to change their behavior but also how they plan to do so, as demonstrated in the context of recycling [27] and sustainable food-purchasing habits [28]. Habitual behavior further makes up the domain of behavioral regulation. Literature has consistently supported the link between habits and pro-environmental action. For example, research on SUP bags finds that habits can act as enablers or barriers to engaging in the desired behavior [29].

Opportunity describes the external social and physical factors influencing an individual to engage in the behavior [12]. Opportunity is required for individuals to be able to engage in a given behavior. Social opportunity arises in the social environment through social and descriptive norms, and social support available to individuals makes the behavior possible or prompts it. Physical opportunity occurs when individuals interact with the environment or events, influencing the viability of the behavior. The research on the role of opportunity and its relationship with behavior in the COM-B model has produced inconclusive evidence.

On the one hand, a range of studies from various contexts suggests a correlation between opportunity and behavior, including energy-saving behaviors [30], online ticket purchases [14] and sedentary behavior [17]. Yet, other studies on virtual co-creation in new product development [15] and electronic word-of-mouth [16] could not produce evidence for a correlation between opportunity and behavior. As such, the direct effect of opportunity on behavior may vary with the target behavior being studied, given opportunity was found to influence energy-saving behavior directly [30], but not physical activity or healthy eating behavior [11]. Two studies by Howlett and colleagues further muddy the relationship between opportunity and behavior; one reveals an indirect correlation between (social) opportunity and physical activity via the mediating effect of motivation [13]. Howlett and colleagues' second work indicates a direct influence of opportunity on motivation and sitting behavior [17]. In a pro-environmental context, physical opportunity is a vital component of behavior change due to its dependence on the circumstances under which behavioral choices are made. Changes in environmental influences are required to facilitate an individual's opportunities to enact sustainable behavior (e.g., using reusable tableware) and to make sustainable behavior choices more attractive [31].

The TDF [18] identifies the domain of social influences under social opportunity, which includes normative measures (i.e., subjective and descriptive norms) and social support. Subjective norms, referred to as the belief that an important person or group of people approve of a particular behavior [32], impact motivation to engage in using reusables, including reusable cups [33,34] and reusable takeaway boxes [35]. Descriptive norms, described as the extent to which behavior is perceived as commonly approved of [36], effectively predict pro-environmental behavior. For example, in the context of energy conservation [37] and household waste recycling [38]. Previous

research has established a correlation between social support and behavior, for instance, in the context of SUP bags [39,40]. The link between social support and general sustainable behavior is further supported by a large body of research on social factors, which are critical influencers for pro-environmental behavior change [41], including social identities [42,43] and social desirability [44–46].

Motivation is an essential factor in the COM-B model and refers to the automatic and reflective motivational processes that energize and direct individuals to perform a behavior [12]. Automatic motivation directs behavior through emotions and impulses. In contrast, reflective motivation directs behavior through decision-making and evaluations of individuals' identity, self-efficacy, perceived behavioral control, attitudes, goals, intentions, and outcome expectancies. The COM-B model suggests that motivation directly influences behavior while mediating the associations between capability, opportunity, and behavior. These links are echoed in past research, which provided evidence for a strong correlation between motivation and behavior [13–16], including support for motivation mediating the effects of capability and opportunity on behavior [11,30].

According to the TDF [18], the automatic motivation domain comprises the sub-categories of emotion (i.e., affect) and reinforcement. Affect plays a vital role in barriers and enablers to the pro-environmental motivation of a less conscious nature, as has been shown in studies on food waste [47,48] and reusable cups [49]. Likewise, reinforcement of both positive and negative character has been shown to facilitate or inhibit pro-environmental motivation [50]. Reflective motivation consists of multiple domains, including social/-professional role and identity, beliefs about capabilities, beliefs about consequences, optimism, intention, and goals. Much research on social/professional roles and identity ascertains that consumers with more significant pro-environmental identities are more likely to engage in eco-friendly behaviors. Here, a strong sense of ingroup membership has been found to make environmental actions more likely [23,42].

Beliefs about capabilities are another important indicator of pro-environmental action, which includes self-efficacy and perceived behavioral control (PBC). Studies have found that feelings of control and an individual's beliefs about whether they can engage in the required action can predict sustainable attitudes and sustained engagement in pro-environmental behavior [51,52]. Concerning feelings of control, beliefs about consequences in the form of instrumental and affective attitudes facilitate pro-environmental actions [53,54]. Likewise, optimism that one's behavior is making a difference, which is studied via outcome expectancies, has been shown to motivate the maintenance of sustainable behavior over time [55].

Intention to perform a behavior is one of the most studied constructs within reflective motivation [56,57] and a key determinant of behavior [32,58]. While intention strongly correlates with behavior, multiple studies have revealed inconsistencies between what people declare they intend to do and what they actually do. This inconsistency is well acknowledged in literature and referred to as the green intention-behavior gap [59] or motivation-behavior gap [60]. Thus, the link to actual behavior is subject to much debate, and intention alone is often not enough to predict behavior [61,62]. Acknowledging the intention-behavior gap, it is clear that intention forms a vital piece in the behavioral puzzle in the context of pro-environmental behaviors, with studies supporting a correlation with behavior [63,64]. Goal setting is an additional essential component of reflective motivation and "self--directed change" [65], which can take the form of a cue-based approach such as implementation intentions [25]. Prompting or incentivizing individuals to think about what steps they will take to engage in sustainable behavior is one way to transition people into more sustainable consumption patterns [26].

Behavior, referred to as any action a person takes in response to internal or external events, is typically measured either overtly and directly or covertly and indirectly [66]. Although individuals are increasingly willing to engage in pro-environmental purchase and consumption behavior, the number of SUP tableware consumed and disposed of has reached a record high during the COVID-19 pandemic. Considering the complexity of the issue, this research employs the COM-B model [11,67] to understand SUP consumption behavior and the full range of potential barriers and enablers of SUP tableware reduction behavior.

In this study, the COM-B framework was applied to understand how people think and feel (Motivation) and to identify levels of personal, social, and environmental support (Capability and Opportunity) available to people to reduce SUP tableware use (Behavior). According to the conceptualization of the COM-B framework, capability, opportunity, and motivation are higher-order constructs, which are formatively associated with lower-order constructs that conceptualize the three antecedents to SUP tableware reduction behavior. Hence, this study hypothesizes that:

H1. Capability, opportunity, and motivation are higher-order constructs formatively associated with lower-order constructs psychological and physical capability, social and physical opportunity, and automatic and reflective motivation, respectively.

H2. Capability positively affects (a) motivation and (b) behavior to reduce SUP tableware.

H3. Opportunity positively affects (a) motivation and (b) behavior to reduce SUP tableware.

H4. Motivation positively affects behavior to reduce SUP tableware.

3. Methodology

Two online surveys were administered to 354 (Study 1) and 644 (Study 2) Chinese participants to empirically examine how capability, opportunity, and motivation explain SUP tableware reduction behavior. Participants were recruited using the panel service provided by a research agency (www.wjx.cn). All measurement items were adapted from prior sustainable behavior research, with slight adaptations for the SUP reduction context. The initial COM-B model has 19 pre-validated factors and one outcome variable (SUP tableware reduction behavior), measured by 90 measurement items. Table 1 shows the COM-B scales, TDF domain, and measures used in the questionnaire. All variables were measured using a 7-point Likert scale (1 – strongly disagree, 7 – strongly agree). Participants provided informed consent before completing the surveys. Data collected in Study 1 was analyzed using exploratory factor analysis (EFA) with SPSS to establish a parsimonious and reliable factor structure for the COM-B measurement model [68]. Study 2 examined the hypothesized relationships using the COM-B framework refined in Study 1 using SmartPLS4. Capability, opportunity, and motivation are reflective-formative higher-order constructs, which were validated using the disjoint two-stage approach of PLS-SEM. A disjoint two-stage approach was utilized to explore the reflective-formative nature of higher-order constructs [69–71].

4. Results

Data collected in Study 1 was analyzed using exploratory factor analysis (EFA) using SPSS to establish a parsimonious and reliable factor structure for the COM-B measurement model [68]. Principal axis factoring extraction with Varimax rotation was used because the data are not normally distributed as indicated by both Shapiro-Wilk and Kolmogorov-Smirnov significance values, which were smaller than 0.05 for all items [68,79]. For each EFA iteration, one item with either an item loading <0.4, a cross-loading greater than 0.3 across three or more factors, or a significant cross-loading on two factors was removed. The KMO measure of sampling adequacy, Cronbach's alpha (reliability), and the total variance explained by the remaining items were examined for

Table 1
COM-B scales, TDF domain, and measures.

COM-B	TDF domain	Measure	Sources
Capability - psychological	Knowledge	Knowledge (KN)	[20–22]
	Memory, attention, and decision processes	Decision making (DM)	[23]
	Behavioral regulation	Action control (AC)	[72]
		Action planning (AP)	[24]
		Habits (HA)	[73]
Capability - physical	Skills	Action skills (AS)	[20,21]
Opportunity - social	Social influences	Subjective norms (SN)	[49]
		Descriptive norms (DN)	[74]
		Social support (SS)	[39,40]
Opportunity - physical	Environmental context and resources	Environment (EN)	[67]
Motivation - automatic	Emotion	Affect (AFF)	[23,49, 67]
	Reinforcement	Reinforcement (RE)	[49,75]
Motivation - reflective	Social role and identity	Identity (ID)	[23,76]
	Beliefs about capabilities	Self-efficacy (SE)	[74]
		Perceived behavior control (PBC)	[77]
	Beliefs about consequences	Attitudes (instrumental and affective) (ATT)	[74]
	Optimism	Outcome expectancies (OE)	[67]
	Intention	Intention (INT)	[77]
	Goals	Goals (GO)	[21]
Behavior		Behavior (BEH)	[49,78]

potential improvement after each item was removed. This iterative process resulted in a factor structure with 12 factors and one outcome variable, comprising 44 items. After extraction, knowledge was removed as a factor for capability. Descriptive norm was removed as a factor for opportunity. Perceived behavior control, intention, affect, attitudes, and outcome expectancies were removed as factors predicting motivation. This finding is consistent with prior studies as people usually do not have concrete factual information on plastic pollution, and the perceived severity of the issue influences their plastic avoidance behavior [21]. Fig. 1 shows the refined theoretical framework.

4.1. Measurement model

Study 2 used the revised survey to examine the proposed hypotheses using SmartPLS4 empirically. First, the validity and reliability of the measurement model were evaluated following Hair et al. guidelines [91] (see Table 2). Indicator reliability was confirmed, as all reflective indicator loadings exceeded 0.708 except for the first item of action skills and behavior, which were 0.673 and 0.678. Since both items were very close to 0.708 and other items of the respective constructs have high loading scores to complement AVE and composite reliability values, the loading of item 1 of action skills and item 1 of behavior was considered adequate to be included [92]. Internal consistency reliability was achieved as the Cronbach's alpha and composite reliability values of all constructs were within the range of 0.70 and 0.90 [93]. Although Cronbach's alpha of action skills and decision-making was <0.70, the value was greater than 0.60 and was acceptable in exploratory research ([91], p. 8). The AVE of all constructs was significant (i.e., greater than 0.50), representing good convergent validity [92]. Finally, discriminant validity was assessed using the HTMT ratio [94]. The HTMT values of all constructs are lower than the 0.90 threshold value, confirming that discriminant validity was present. Table 3 summarizes the HTMT matrix of the constructs.

4.2. Higher-order construct

After validating the measurement model and the lower-order constructs (LOCs) — action control, action planning, action skills, decision making, environment, goals, habits, identity, reinforcement, self-efficacy, social norms, and social support — the reflectively measured LOCs were computed into latent variables to evaluate the higher-order constructs (HOCs) using a disjoint two-stage approach [69]. Redundancy analysis with a global single item revealed that the path coefficients for opportunity (0.753), capability (0.711), and motivation (0.717) exceeded the 0.70 threshold [70], confirming the convergent

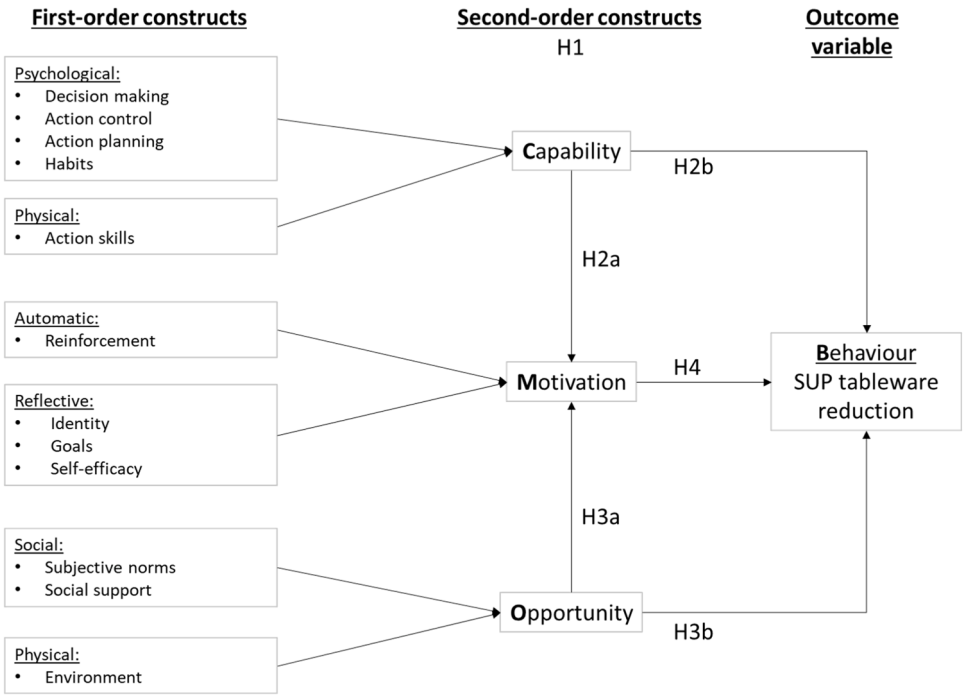

Fig. 1. Refined theoretical model.

Table 2
Assessment of measurement model.

Lower-order Constructs	Items	Loadings	AVE	Composite Reliability	Cronbach's Alpha
Action control	*During the past month (30 days), I have…*		0.687	0.897	0.847
	1. constantly monitored whether I reduced usage of SUP tableware	0.860			
	2. watched carefully that I use plastic-free alternatives	0.857			
	3. made sure to use fewer SUP tableware	0.810			
	4. always been aware of my plan to reduce the usage of SUP tableware	0.785			
Action planning	*During the past month, I have made a detailed plan regarding …*		0.635	0.874	0.810
	1. reducing my use of SUP tableware.	0.822			
	2. changing where I purchase food and beverages to avoid using SUP tableware.	0.841			
	3. carrying reusable tableware	0.759			
	4. how much I purchase takeaway food and beverages to avoid using SUP tableware.	0.768			
Action skills			0.562	0.791	0.606
	1. I know how to carry, use, and clean reusable tableware	0.673			
	2. I know where to purchase food & beverages with plastic-free alternatives	0.832			
	3. I know how to choose plastic-free alternatives	0.776			
Decision making	*When it comes to deciding on whether to use fewer SUP tableware or not,*		0.587	0.809	0.652
	1. I would fulfill my moral obligation to reduce plastic waste	0.715			
	2. I would feel good if I used fewer SUP tableware	0.738			
	3. I would be a better person if I used fewer SUP tableware	0.840			
Environment			0.713	0.881	0.805
	1. Cleaning reusable tableware is inconvenient*	0.805			
	2. Carrying reusable tableware is annoying*	0.919			
	3. There aren't enough facilities to clean reusable tableware*	0.804			
Goals	*In the past month, how often have you set a goal to…*		0.706	0.906	0.861
	1. use fewer SUP tableware	0.792			
	2. buy plastic-free food or drinks even if it costs more	0.835			
	3. change the store you go for shopping in order to reduce using SUP tableware	0.893			
	4. not to purchase takeaway food or beverages to avoid using SUP tableware	0.839			
Habits	*Avoid using SUP tableware is something …*		0.767	0.908	0.849
	1. I do without thinking	0.812			
	2. That belongs to my (daily) routine.	0.910			
	3. I have been doing for a long time	0.904			
Identity			0.675	0.862	0.760
	1. I think of myself as a consumer who is trying to avoid using SUP tableware	0.785			
	2. I think of myself as someone very concerned with minimizing the use of SUP tableware	0.841			
	3. To avoid using SUP tableware is an important part of who I am as a person	0.837			
Reinforcement	*How likely are you to avoid using SUP tableware …*		0.771	0.870	0.710
	1. if plastic straws are not given to me unless requested	0.920			
	2. if plastic cutlery is not given to me unless requested	0.833			
Self-efficacy			0.634	0.838	0.714
	1. I believe I can avoid using SUP tableware	0.768			
	2. I am optimistic that I can avoid using SUP tableware	0.776			
	3. I am confident that I could avoid using SUP tableware	0.843			
Social norms			0.652	0.882	0.821
	1. Most people in my social network think I should use SUP tableware less	0.769			
	2. Most of my friends avoid using SUP tableware	0.864			
	3. Most of my family avoids using SUP tableware	0.749			
	4. Most of my co-workers/classmates avoid using SUP tableware	0.841			
Social support	*In the past month (30 days), how often have other people …*		0.833	0.937	0.900
	1. encouraged you to avoid using SUP tableware	0.912			
	2. reminded you to avoid using SUP tableware	0.921			
	3. helped you to stop using SUP tableware	0.905			
Behavior	*In the past month, how often have you …*		0.556	0.862	0.799
	1. used plastic straws when buying a cold drink at a café, restaurant, or bar*	0.678			
	2. used disposable cups when buying a hot beverage*	0.732			
	3. avoided using SUP tableware by not buying takeaway food and beverages	0.714			
	4. changed the store I go for shopping in order to reduce using SUP tableware	0.824			
	5. pay more for plastic-free alternatives (e.g., biodegradable coffee cups or cutlery)	0.771			

(Remarks: * items are reverse scored).

validity of all HOCs. The findings from the HOC assessment (see Table 4) showed that the VIF values for all LOCs ranged from 1.090 to 2.586, indicating no multicollinearity issues since all values were below 3 [80]. Additionally, the outer weights for all lower-order constructs (LOCs) were statistically significant, validating the higher-order formative constructs of capability, opportunity, and motivation. As all criteria presented in Table 4 were satisfied, the validity of the HOCs was established. Thus, the results confirmed hypothesis H1, that capability, opportunity, and motivation are higher-order constructs comprising LOCs as conceptualized based on the COM-B framework. Capability is found to be predicted by five LOCs, including action control, action planning, action skills, decision-making, and habits. Opportunity was associated with three LOCs (social norms, social support, and environment). Four factors (identity, reinforcement, goals, and self-efficacy) were LOCs for motivation in the refined model.

Table 3
Assessment of discriminant validity (HTMT ratio).

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Action control													
2. Action planning	0.584												
3. Action skills	0.689	0.546											
4. Behavior	0.712	0.621	0.669										
5. Decision making	0.558	0.363	0.470	0.311									
6. Environment	0.399	0.526	0.533	0.400	0.229								
7. Goals	0.591	0.831	0.582	0.699	0.362	0.426							
8. Habits	0.639	0.888	0.530	0.536	0.410	0.472	0.710						
9. Identity	0.827	0.568	0.809	0.661	0.649	0.411	0.634	0.635					
10. Reinforcement	0.483	0.256	0.426	0.336	0.446	0.365	0.243	0.323	0.422				
11. Self-efficacy	0.638	0.485	0.734	0.426	0.721	0.407	0.509	0.580	0.821	0.466			
12. Social norms	0.715	0.444	0.696	0.525	0.489	0.440	0.421	0.479	0.765	0.461	0.687		
13. Social support	0.542	0.759	0.540	0.618	0.293	0.459	0.709	0.719	0.625	0.230	0.449	0.638	

Table 4
Assessment of higher-order constructs.

HOC	LOC	Outer weights	t-statistics	p-values	Outer loadings	VIF
Capability	Action control	0.465	7.201	0.000	0.892	1.916
	Action planning	0.243	3.834	0.000	0.756	2.448
	Action skills	0.222	4.451	0.000	0.709	1.536
	Decision making	0.176	3.276	0.001	0.647	1.441
	Habits	0.171	2.924	0.003	0.761	2.586
Opportunity	Social norms	0.608	5.287	0.000	0.882	1.688
	Social support	0.256	9.333	0.000	0.740	1.571
	Environment	0.409	8.228	0.000	0.673	1.135
Motivation	Identity	0.423	8.360	0.000	0.859	1.999
	Reinforcement	0.331	9.342	0.000	0.566	1.090
	Goals	0.356	7.753	0.000	0.765	1.519
	Self-efficacy	0.237	3.770	0.000	0.744	1.578

4.3. Structural model and hypothesis testing

The structural model and hypotheses were evaluated following the PLS-SEM reporting guidelines [70,71] (see Table 5). The VIF of each set of independent constructs ranged from 2.288 to 3.484, showing the structural model has no collinearity issues as all VIFs were between 0.2 and 5. Then, bootstrapping with 10,000 subsamples was performed to examine the significance of relationships between constructs of the hypothesized model. Capability ($\beta = 0.573$; $p \leq 0.01$) and opportunity ($\beta = 0.323$; $p \leq 0.01$) were positively associated with motivation, supporting hypotheses H2a and H3a. However, capability ($\beta = -0.049$; $p = 0.477$) and opportunity ($\beta = 0.069$; $p = 0.234$) were not associated with behavior, rejecting hypotheses H2b and H3b. While motivation significantly affected behavior ($\beta = 0.515$; $p \leq 0.01$), supporting hypothesis H4 and revealing a full mediation effect of capability and opportunity on behavior through motivation. Next, the explanatory power of the hypothesized model was examined based on the R^2 value of the endogenous constructs. The hypothesized model explained 70.0 % of the variance for motivation and 47.7 % for SUP reduction behavior, reflecting substantial explanatory power. All effect sizes between capability, opportunity, and motivation on behavior were smaller than 0.15, indicating small effects on the endogenous construct. However, strong effect sizes were observed between the relationship of capability ($f^2 = 0.523$) and opportunity ($f^2 = 0.120$) on motivation, indicating a medium to large effect of capability and opportunity on motivation. The predictive accuracy of the path model was assessed using the Q^2 value calculated using $PLS_{predict}$ [70]. All Q^2 values were greater than zero ($Q^2_{predict}$ motivation = 0.691; $Q^2_{predict}$ behavior = 0.428), showing that the exogenous constructs have predictive relevance for the endogenous constructs of the model. Prediction statistics were also examined following the guidelines of Shmueli, et al. [81]. While some indicators of behavior (see Table 6) yielded higher prediction errors than the LM_RMSE, the hypothesized model has medium predictive power. Fig. 2 shows the results of the theoretical model evaluation.

Table 5
Hypothesis testing.

Path	Path coefficients	t-statistics	p-values	Supported?	VIF
H2a: Capability -> Motivation	0.573	15.111	0.000	Yes	2.288
H2b: Capability -> Behavior	−0.049	0.711	0.477	No	3.484
H3a: Opportunity -> Motivation	0.323	8.508	0.000	Yes	2.288
H3b: Opportunity -> Behavior	0.069	1.190	0.234	No	2.563
H4: Motivation -> Behavior	0.515	7.359	0.000	Yes	3.331

5. Discussion

This study contributes to the literature by validating the adoption of the COM-B model as the underpinning theory and mapping with TDF as an instrument that measures consumers' behavior in the context of SUP tableware reduction. Although knowledge was considered an essential enabler of individuals' capability to reduce SUP [19], this has not been included in the scale developed in this study after the EFA iteration process. This is likely due to individuals participating in SUP reduction

Table 6
Assessment of prediction statistics.

	$Q^2_{predict}$	PLS-SEM_RMSE	LM_RMSE	PLS-SEM_RMSE - LM_RMSE
Behavior1	0.200	1.268	1.268	0.000
Behavior2	0.259	1.346	1.349	−0.003
Behavior3	0.183	1.445	1.450	−0.005
Behavior4	0.260	1.425	1.410	0.015
Behavior5	0.283	1.360	1.353	0.007

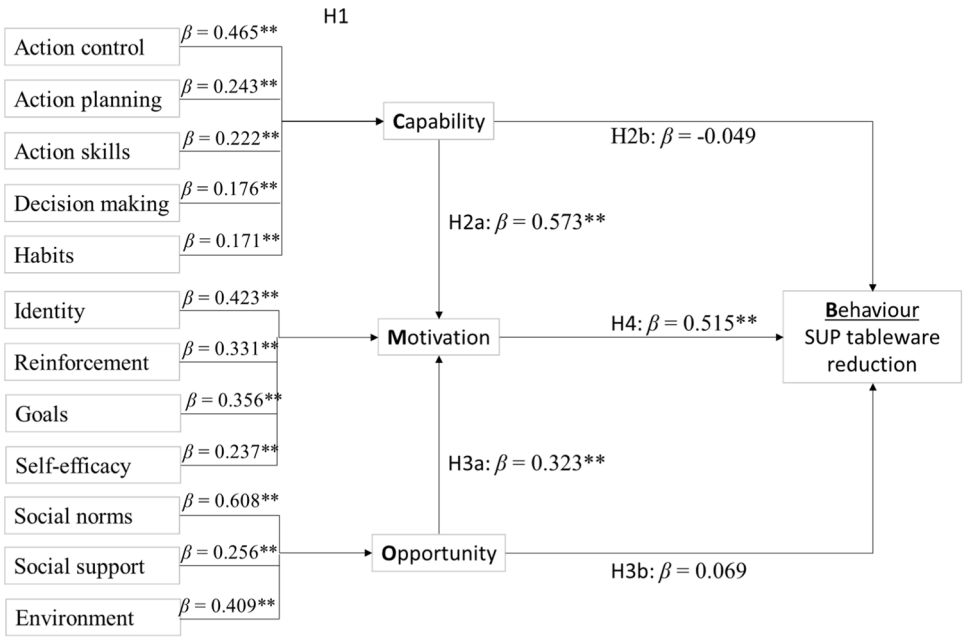

Fig. 2. Results of hypotheses evaluation (* $p < 0.05$, ** $p < 0.01$).

behaviors often lacking clear information about plastic pollution [21]. A significant number of survey participants did not provide correct answers to the questions in the "knowledge" construct, such as *"I know what the top 10 SUP items are"* and *"I know which plastic items constitute the biggest number of plastics that enter the ocean"*. Although individuals may reduce SUP usage due to an understanding of the detrimental effects of plastic pollution, they often lack precise knowledge or statistics regarding the severity of the issue. Furthermore, the exclusion of "knowledge" as a construct during factor analysis can be substantiated by findings from previous studies. A systematic review of SUP reduction interventions indicated that programs aimed at increasing knowledge do not effectively influence consumers to reduce SUP usage [82]. On the other hand, the specific knowledge in reducing consumption of SUP tableware, measured by action skills, was found to be more prominent in enabling capability in SUP reduction. The validated model addressed the complexity of SUP tableware reduction behavior, extending consideration to the potential influence of environmental factors [9].

The findings showed that the LOCs of capability include action control, action planning, action skills, decision-making, and habits. Consistent with the literature, the capability to reduce SUP tableware use relies on psychological and physical capability [12,13,17]. These results suggest that individuals are more likely to reduce the use of SUP tableware when they perceive themselves as capable of performing SUP reduction behavior. Furthermore, the results showed that social norms, social support, and environment are LOCs of opportunity. Social influences and support are important in influencing individuals to engage in SUP tableware reduction. Studies in different behavioral contexts have widely supported the link between social factors and pro-environmental behaviors [39,41,53]. Four LOCs were associated with motivation: identity, reinforcement, goals, and self-efficacy. This finding suggested that individuals' motivation to reduce SUP tableware is mainly driven by reflective motivation, such as perceived social roles, goals to be achieved, belief in their capability, and perceived difficulty or easiness [42,52]. For reinforcement, it is worth highlighting that two measurement items *("If the stores offer an incentive to use reusable tableware" and "If I have to pay an extra fee for using plastic tableware")* related to monetary incentive were not loaded into the factor. This observation aligns with previous studies, which suggest that financial nudges may be ineffective in promoting long-term pro-environmental behaviors [83]. Interestingly, intention, affect, PBC, attitudes, and outcome expectancies did not affect individuals' motivations to reduce SUP use. This may be due to the availability of SUP products as a more convenient choice for customers regardless of their environmental attitudes and beliefs [84,85].

In the path analysis, motivation directly influenced SUP tableware reduction behaviors, while the impact of capability and opportunity on behaviors was fully mediated by motivation. These significant paths are consistent with the prior research studies, which demonstrated a strong relationship between motivation and behaviors as well as the mediating role of motivation [11,13,15,30]. This study found that motivation fully mediates the effect of capability and opportunity on SUP reduction. This finding indicates that even with capability (psychological and physical capacity) and opportunity (social and external influences), individuals must be motivated to engage in the behavior. Reducing SUP is a high-involvement behavior requiring individuals to exert additional effort (e.g. "avoid using SUP tableware by not buying takeaway food and beverages"; "change the store I go for shopping in order to reduce using SUP tableware") and incur extra costs (e.g. pay more for plastic-free alternatives such as biodegradable coffee cups or cutlery). It is crucial for consumers to be motivated to participate in these activities, as being knowledgeable, capable, or socially desirable alone will not suffice. From a theoretical perspective, the analysis demonstrated the pathways of COM in influencing SUP table reduction. This investigation allows us to describe relationships more clearly between the COM constructs, illuminating the indirect influence of capability and opportunity and demonstrating the contribution of these HOCs on an individual's motivation to reduce SUP.

6. Implications and further studies

This study provides actionable insights for social marketers, behavior change practitioners, and policymakers on the critical enablers that encourage the reduction of the behaviors of SUP tableware. The motivation demonstrated a direct impact on consumers' behaviors. The essential enablers based on the LOCs are mainly reflective motivations. Intervention or communication campaigns should foster a sense of social identity, enhancing individuals' beliefs on their capacity to reduce SUP or making it easier for individuals to perform SUP reduction behaviors. For instance, interventions might be designed to engage people in activities that help them develop their sense of social or environmental

identity, and messages might be delivered to highlight the alternatives to SUP tableware, which would drive higher levels of reduction behaviors. Intervention designers or policymakers could integrate strategies to enable capability and opportunity that subsequently affect motivation, for example, support planning, skills, maintenance of SUP tableware reduction by providing information about or giving out reusable tableware (capability), and improve the social environment by highlighting the environmental lifestyles as a trend and encouraging a supportive environment for using reusable tableware (opportunity).

In light of these findings, governments and politicians should prioritize developing regulations that enhance both automatic and reflective motivations for reducing SUP tableware usage. The study indicates that consumers are less likely to use SUP when they are not provided unless requested, supporting recent actions by the Hong Kong government to prohibit catering establishments from offering such items automatically (GovHK, 2023). However, existing policies do not adequately address reflective motivations within the COM-B framework. To complement restriction policies, motivation driven by self-identity and self-efficacy should be prioritized by intervention designers and policymakers. The findings suggest that consumer behavior in reducing SUP is closely linked to identity and self-efficacy constructs. To strengthen reflective motivations, governments should implement initiatives that raise awareness about the environmental impacts of SUP and promote alternative options. Education can help consumers understand alternatives such as reusable items, biodegradable products, and innovative materials, thereby enhancing their self-efficacy.

Although opportunity and capability do not directly correlate with SUP reduction behavior, they significantly influence motivation. Given the urgent need to inspire more consumers to protect the environment, collaboration between the business sector and government agencies is essential to enhance capabilities and opportunities for reducing SUP. The results indicate that individuals are more likely to reduce SUP usage when they feel capable of doing so. Thus, strategies to increase perceived capability are critical. For example, food delivery services could display data on the number of meals delivered without SUP on a weekly or monthly basis, reinforcing customers' perceived capability. Additionally, if cumulative data on customers' SUP reduction efforts are showcased in an app, rewards and incentives—such as discounts or free delivery—could be offered when customers reach specific milestones (e.g., 20 meals per month). This approach encourages decision-making, planning, action, and rewards, fostering positive habits in reducing SUP usage. Furthermore, to incentivize business participation, subsidies or tax reductions could be introduced for companies whose customer base achieves significant reductions in SUP consumption.

Governments can also enhance the opportunity construct of the COM-B model and foster motivation by implementing various strategies to incentivize business managers in reducing SUP consumption. Tax breaks for companies adopting eco-friendly practices, such as using biodegradable materials, encourage sustainable alternatives; for instance, Thailand offers a 25 % corporate income tax reduction for businesses purchasing biodegradable products [86]. Grants can support investments in sustainable packaging solutions, alleviating initial transition costs. Recognition programs that award certifications for significant reductions in plastic usage can motivate competition among peers [87]. Additionally, businesses can engage in plastic offset programs, investing in projects aimed at reducing plastic waste [88]. These initiatives create a supportive environment and opportunity that fosters positive subjective norms and encourages consumers to adopt reusable options, ultimately leading to a collective effort to reduce SUP consumption. By normalizing the use of reusables and celebrating citizens who adopt these behaviors, communities can cultivate a culture of sustainability that motivates further action against plastic pollution.

Future research is recommended to address the limitations of this study. First, the current study was conducted through two online surveys in a Chinese context. In China, as in many countries prioritizing collectivism, there is a significant emphasis on social harmony and conformity. This cultural orientation can impact individuals' behaviours, attitudes, and responses in pro-environmental research contexts, potentially leading to varied interpretations of survey questions or behavioural assessments when compared to samples from more individualistic cultures [89]. Future cross-cultural validation studies should be conducted by replicating the analysis in other cultural contexts. Although measures were taken to minimize potential bias in this study, the self-report measures may result in social desirability and self-selection biases. The study's reliance on cross-sectional data and self-reported surveys, along with its focus solely on Chinese samples, may affect the generalizability of the findings. However, the study highlights the significance of motivation in promoting voluntary SUP reduction behavior and future studies are suggested to use objective-measured SUP tableware reduction (e.g., monitoring actual reductions in SUP usage or purchasing patterns among consumers and catering settings). Finally, as suggested in a recent study by Willmott, Pang and Rundle-Thiele [11], future research may consider integrating other frameworks or contextual moderators (e.g., environmental barriers) into the COM-B framework, enhancing the explanatory power of the COM-B framework.

7. Conclusions

The objective of this study is to understand the factors influencing individuals' voluntary behavior to reduce SUP tableware consumption through the COM-B model and the TDF. The study seeks to evaluate the effectiveness of the COM-B model as a framework for assessing individuals' thoughts and feelings (Motivation) and determining the levels of personal, social, and environmental support (Capability and Opportunity) available to them to reduce SUP tableware consumption (Behavior). A measurement instrument based on the COM-B model with 12 factors and one outcome variable, comprising 44 measurement items was developed and validated. The findings support the explanatory potential of the COM-B model in motivating consumers to reduce SUP tableware usage. Path analysis revealed that motivation directly influences behaviors related to SUP reduction, while capability and opportunity impact behaviors only through motivation. Therefore, motivation is the most dominant tool compared to opportunity and behavior in influencing individuals' voluntary actions to decrease SUP consumption. Specifically, motivation, measured formatively by lower-order constructs such as identity, reinforcement, goals, and self-efficacy, is the most significant predictor of SUP tableware reduction behavior, explaining approximately 48 % of the actual reduction behavior. This indicates that individuals who have a strong sense of identity related to environmental protection, who receive positive reinforcement, who have clear goals for reducing SUP usage, and who believe in their capability to make a difference are more likely to engage in behaviors that reduce SUP consumption. Capability, associated with action control, action planning, action skills, decision-making, and habits, plays a crucial role in influencing motivation. Individuals who are capable of controlling their actions, planning effectively, possessing the necessary skills, making informed decisions, and developing habits around SUP reduction are more likely to feel motivated to reduce their SUP usage. Enhancing these capabilities can thus indirectly drive SUP reduction behaviors through increased motivation. Opportunity, linked to social norms, social support, and the environment, also influences motivation. When individuals perceive social norms that favor SUP reduction, receive support from their social circles, and operate within an environment that encourages sustainable practices, they are more likely to feel motivated to reduce their SUP consumption. Creating opportunities through community engagement, supportive policies, and an encouraging environment can significantly boost motivation and subsequent behaviors. The model explains 70 % of motivation in SUP tableware reduction, showcasing the interconnectedness of capability, opportunity, and motivation in driving behavior change. By understanding and leveraging these factors, policymakers and social marketers can develop

targeted interventions that effectively promote sustainable behaviors.

Capability is predicted by factors such as action control, which allows individuals to regulate their behaviors; action planning, which involves strategizing for SUP reduction; action skills, which are the practical abilities needed to reduce SUP usage; decision-making, which entails making informed choices; and habits, which are routine behaviors that support SUP reduction. Strengthening these elements can enhance an individual's overall capability to engage in SUP reduction. Opportunity is associated with social norms that dictate acceptable behaviors, social support that provides encouragement and resources, and environmental conditions that facilitate or hinder SUP reduction. By fostering a supportive social and environmental context, opportunities for SUP reduction can be increased, thereby enhancing motivation and behavior change. Overall, the study highlights the importance of motivation as a direct influence on behavior, with capability and opportunity serving as important mediators. The findings underscore the need for comprehensive strategies that address all aspects of the COM-B model to effectively promote the reduction of SUP tableware usage.

This study makes both theoretical and practical contributions to the literature on social marketing and pro-environmental behaviors. Theoretically, our research is a first step towards developing a formative higher-order measurement model in SUP tableware reduction. This study contributes to the body of literature by advancing knowledge on using the COM-B model to understand SUP reduction. Specifically, this project responds to the need to explore whether the COM-B model can be used as an integrated measurement approach that can be applied to guide intervention approaches [11]. While other extant studies focus on the typical side of policy interventions, waste education, and moral reframing [4,23,76,90], this study provides a unique perspective by applying the COM-B model and TDF to understand the psychological and behavioral factors that motivate individuals to reduce SUP tableware voluntarily. Understanding behavioral nudges also provides practical implications for policymakers, social marketers, and environmental advocates to formulate effective interventions that bridge the attitude-behaviour gap in reducing SUP consumption. Future research is suggested to validate the findings of this study across different sample compositions and settings. Objective-measured behaviors would also be beneficial in comprehending the consumers' behavior in reducing the use of SUP tableware.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used [Grammarly and Microsoft Co-pilot] in order to check grammar and rephrase sentences to enhance the clarity of the manuscript. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

CRediT authorship contribution statement

Daisy Lee: Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Calvin Wan:** Writing – original draft, Validation, Methodology, Conceptualization. **Sebastian Isbanner:** Writing – original draft, Methodology, Investigation, Conceptualization. **Sharyn Rundle-Thiele:** Writing – review & editing, Validation, Methodology, Conceptualization. **Yi-Ning Fung:** Writing – original draft.

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.

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Data availability

Data will be made available on request.

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