第10卷，第A50-A69 頁 | 2024
doi: 10.6858/GE.202408_10.0003

Elucidating the Factors Influencing Consumers' Intentions to Reduce Single-Use Tableware in a Public Health Crisis

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Article Information

Accepted: 2025.02
Keywords:
- consumers' intentions
- COVID-19
- PLS-SEM
- public health
- single-use tableware
- theory of planned behavior

Abstract

Although combating single-use products like tableware seem deterred by hygienic concerns associated with a public health crisis as COVID-19, what exactly consumers perceive about their application before and after the pandemic remains unexamined. This study explores and compares consumers' intentions to reduce their usage of single-use tableware (SUT), the predictors as well as the effect differences of predictors on intentions before and after the outbreak of COVID-19. An extended theory of planned behavior (TPB), greenwashing and past behavior included, serves as the analytical model, while the partial least squares structural equation modeling (PLS-SEM) approach is employed in the model's estimation. The results show that either before or after the outbreak of the pandemic, perceived behavioral control represents the primary driver of consumers' intentions to reduce SUT, followed by subjective norms and attitudes. However, consumers' intentions depend more on their own attitudes than others' opinions after the outbreak. The effect of greenwashing is not found, while past behavior becomes influential on consumers' reduction intentions in the public health crisis. In addition, contrary to the instincts, consumers' intentions to reduce SUT show no statistical difference before and after the outbreak of COVID-19. These findings imply that the common measures of (re-)introducing SUT during the pandemic should not be the only solution given the concerns of public hygiene when consumers are still willing to make efforts to combat single-use materials. The promotion of the consumers' perceived behavioral control, subjective norms or attitudes during this period of time can mitigate the possible wastage of resources and environment-related disasters brought about by the public health crisis.

1. Introduction

Single-use materials are not only exhausting resources, but are burdening waste management. To respond to the above growing concerns, several countries in the world have introduced policies that have imposed bans on applying single-use materials, particularly single-use plastics (SUPs), in recent years. However, public health crises, the COVID-19 pandemic in particular, have greatly disrupted this agenda. During the COVID-19 pandemic, concerns over cross-contamination had urged adjustments in related policies, with some governments reintroducing SUPs, some delaying SUPs bans, and some even banning the use of reusable alternatives (Silva et al., 2020). However, without further examining consumers' intentions to reduce the application of single-use materials during a public health crisis, the above policy adjustments remain unjustified. Therefore, this article aims to explore consumers' intentions to reduce the usage of single-use tableware (SUT hereafter) both before and after the outbreak of COVID-19.

While eating out and taking food away have both been common, SUT has been widely made available for convenience and reassurance. In relation to the various single-use materials, Taiwan has implemented bans on SUPs step by step since 2002. The application of SUT back then accounted for around 59,000 tons in total and 2.5 kilograms per inhabitant annually (DGBAS, 2003).

Faced with the regulations concerning SUPs, some users have turned to reusable options. Others have adopted alternatives, mostly bioplastics and paper. For example, 159,897 tons (6 kilograms per inhabitant) of single-use paper tableware were collected for recycling in 2020 according to the Environmental Protection Agency (EPA hereafter) (2021). The non-reusable alternatives, nevertheless, remain single-use.

After the outbreak of COVID-19 in early 2020, Taiwan faced difficulties in combating SUT. Although there were no lockdowns at that time, the Centers for Disease Control in Taiwan (CDC-Taiwan hereafter) published guidelines and applied moral suasion to encourage the implementation of social distancing (CDC-Taiwan, 2020). The EPA temporarily suspended the ban on SUT in March 2020 for safety and hygienic reasons. Restaurants adopted precautionary measures including checking body temperature, disinfecting hands, applying table partitions, forcing face-mask wearing except for eating, and re-introducing SUT.

Although the relaxation of the SUPs ban may have been temporary, researchers such as Vanapalli et al. (2021) felt that the possible implications for consumers' perceptions could alter consumers' behavior and risk a return to the throw-away culture. However, most of the related literature, as Parashar and Hait (2021) indicated in their review study, mainly addresses the environmental impacts of SUPs during the COVID-19 pandemic. For example, the waste generated by plastic-based personal protective equipment (PPE), such as face masks and hand gloves, has been one of the major concerns among the various types of environmental issues during the pandemic. The increasing and excessive use of PPE induces worries and is one of the main sources of single-use products (Tobías, 2020; Vanapalli et al., 2021). PPE has also recently become one the worst categories of marine litter (Fadare and Okoffo, 2020). Moreover, solutions proposed to reduce single-use materials are mainly technical measures, such as alternatives like bioplastics (Silva et al., 2021; Vanapalli et al., 2021; Parashar and Hait, 2021), and decontamination techniques (Parashar and Hait, 2021).

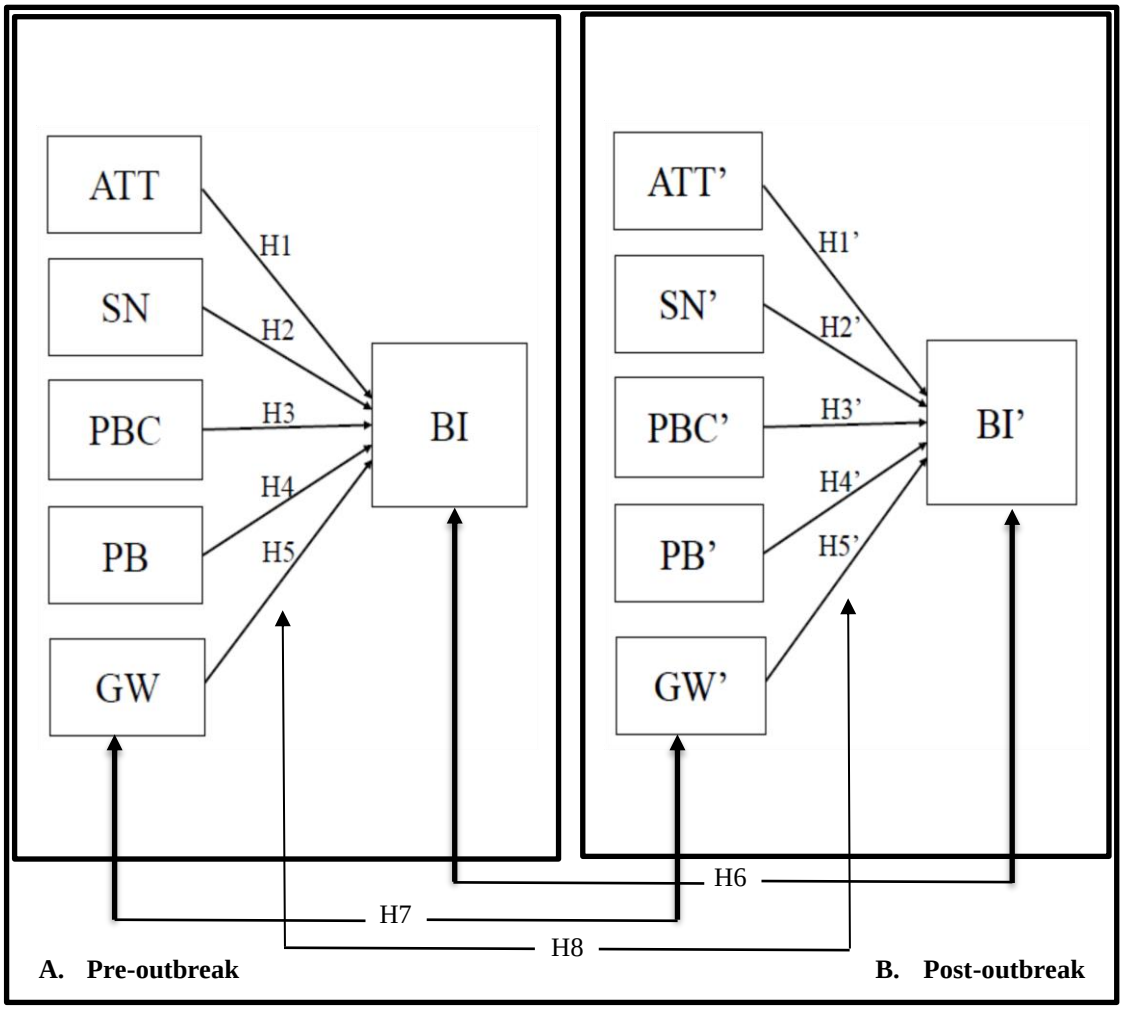
However, what exactly do consumers perceive about the use of SUPs or other single-use materials during the COVID-19 pandemic? Do their perceptions differ from those before the outbreak? To fill a gap in the research literature that has seldom examined consumer's behavioral intentions and the likely changes during the pandemic, this study explores the consumers' behavioral intentions to reduce the application of SUT before and after the outbreak of COVID-19. An extended theory of planned behavior (extended TPB), including variables for greenwashing and past behavior, is specified as the

analytical model. We apply the survey data from college students and use a partial least squares structural equation modeling (PLS-SEM) approach to perform the estimation.

The remainder of this article is organized as follows. In Section 2, we present the theoretical framework and research hypotheses. Section 3 outlines the methodology. Section 4 incorporates the findings and analysis. Section 5 provides a discussion and Section 6 concludes.

2. Theoretical background

This article develops an analytical model based on an extended theory of planned behavior (Figure 1). Pre-outbreak and post-outbreak behavioral intentions as well as associated factors are compared.



Note: BI/BI': behavioral intention; ATT/ATT': attitude; SN/SN': subjective norms; PBC/PBC': perceived behavioral control; PB/PB': past behavior; GW/GW': greenwashing.

Figure 1. The extended TPB research framework and corresponding hypotheses

TPB has been widely applied to predict and explain diverse behavioral intentions in different fields. In TPB, an individual's behavior is assumed to be determined by her/his intention. Three components, namely, the attitude towards the behavior, subjective norms, and perceived behavioral control, influence the intention (Ajzen, 1991).

Among other things, TPB has been applied in several fields of waste reduction, such as analyzing consumers' intentions to reduce food waste (Stefan et al., 2013; Graham-Rowe et al., 2015; Mondéjar-Jiménez et al., 2016; Visschers et al., 2016; Russell et al., 2017; Thompson et al., 2020), to visit green hotels with resource conservation and waste reduction (Han et al., 2010; Chen and Tung, 2014; Yeh et al., 2021), to use plastic bags (Sun et al., 2017), to recycle solid waste (Nigbur et al., 2010; Knussen et al., 2004; Wan et al., 2014; Pakpour et al., 2014), to return/reduce solid waste (Khan et al., 2019), and to apply reusable containers (Ertz et al., 2017).

Attitude (ATT) refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior (Ajzen, 1991). Several empirical findings confirm attitude to be a predictor of intention in reducing single-use materials. The material plastic is the most frequent modality in the discussion. For example, Van Rensburg et al. (2020) find that beachgoers in Durban, South Africa have a generally negative perception towards single-use plastic and a strong willingness to reduce their consumption of single-use plastic. Jezewska-Zychowicz and Jeznach (2015) suggested that a positive attitude towards the environment is associated with claiming not to buy food in disposable plastic or paper packaging. On the other hand, a negative attitude is more related to doing nothing to minimize waste packaging. Fuentes et al. (2019) find that packages are seen as problematic and evoke strong negative feelings to consumers of package-free shopping. The research outcome of Ertz et al. (2017) confirms that consumers' attitudes towards using reusable products is positively related to their intentions to use reusable products. The following hypothesis is thus proposed:

H1: The individual's attitude towards the reduction of SUT positively influences his/her intention to reduce the SUT application.

Subjective norms (SN) refer to perceived social pressure to exhibit or not to exhibit certain kinds of behavior (Ajzen, 1991). Ertz et al. (2017) find that when a respondent considers that people important to him/her would be positive about his/her using reusable products, he/she demonstrates a higher level of intention to apply reusable products. Choi and Johnson (2019) as well as Yadav and Pathak (2016) suggest that believing in the important others would think that purchasing green products is a good thing to do is one of the most direct predictors of the intention to purchase green products. Subjective norms are also found in Nigbur et al. (2010) and Khan et al. (2019) as one of the major predictors of consumers' return/recycling intentions. Here we propose our second hypothesis:

H2: The consumer's subjective norms associated with the reduction in SUT positively influence his/her intention to reduce the SUT application.

Perceived behavioral control (PBC) refers to the perceived ease in performing the behavior (Ajzen, 1991). Ertz et al. (2017) suggest that finding it easy to use reusable products contributes to the intention to use reusable products. Perceived behavioral control is also found to be significantly related to the intention to recycle household waste (Nigbur et al., 2010; Knussen et al., 2004), to reduce food waste (Mondéjar-Jiménez et al., 2016), and to green buying behavior (Kumar, 2021). Therefore, we propose the following hypothesis.

H3: The consumer's perceived behavioral control in relation to reducing SUT positively influences his/her intention to reduce the SUT application.

Past behavior (PB) is included as a construct in our extended TPB model. Although Ajzen (1991) argues that past behavior should not be differentiated as an independent variable and could be explained by attitude, subjective norms, and perceived behavioral control, experience and habit may play a predominant role in influencing the intention to exhibit (sustainable) consumption behavior. For instance, past recycling is found to have a significant contribution in predicting intentions to recycle household waste in Glasgow (Scotland) with relatively poor recycling facilities (Knussen et al., 2004) as well as in Qazvin (Iran) (Pakpour et al., 2014). The following hypothesis is thus proposed:

H4: The consumer's past behavior in relation to reducing SUT positively influences his/her intention to reduce the SUT application.

Greenwashing refers to misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service means greenwashing (Delmas and Burbano, 2011; cited from TerraChoice). Because the single-use alternatives of SUPs, paper and bioplastics alike, are advocated as either recyclable or biodegradable, consumers are usually under the impression that these alternatives are environmentally friendly. However, this impression overlooks the fact that the products remains single-use and are not strictly environmentally friendly. In fact, tableware that is single-use but recyclable might result in problems such as low recyclability (Satapathy and Patankar, 2024) and Per- and Polyfluoroalkyl Substances (PFAS) contamination (Straková et al., 2023). The biodegradable plastic option turns out to be rarely under appropriate conditions for decomposing after being disposed of (Nazareth et al., 2019), let alone cases of false claims of biodegradability (Viera et al., 2020). Therefore, if consumers are misled and consider these single-use alternatives as being environmentally friendly, they might use or even increase his/her use of the so-called environmentally friendly SUT. Here we consider this situation by a variable of greenwashing (GW), which may impede consumers' intentions to reduce SUT. Hence, the following hypothesis is tested:

H5: Greenwashing negatively influences consumers' intentions to reduce the SUT application.

Despite the long-term endeavor to reduce SUT, the outbreak of COVID-19 poses a challenge to its continuation. Not merely the rollbacks of SUPs bans (Vanapalli et al., 2021), but the increase in waste is reported as a negative side effect of COVID-19 in several studies (c.f., Zambrano-Monserrate et al., 2020; Filho et al., 2021; Silva et al., 2021). Although Severo et al. (2021) find that COVID-19 positively influences sustainable consumption based on surveys in Brazil and Portugal, the mean of the respondents' answers to the related issue that the "pandemic caused me to reduce waste production through prevention, reuse, and recycling" appears to be the second lowest (2.661, on a 5-point Likert scale ranging from 1 totally disagree to 5 totally agree) in terms of the responses to the five questions within the sustainable consumption construct. Besides, hygienic concerns during COVID-19 led to an expected increase in food packaging plastic (Sharma et al., 2020). We may also observe an increase in single-use cutleries for both eat-in and take-away to avoid contamination. The aforementioned relaxation of governmental regulations and consumers' health concerns associated with the pandemic might discourage consumers' intention to reduce their use of SUT. Here we propose the following hypothesis:

H6: Consumers' behavioral intentions to reduce the SUT application are lower after the outbreak of the COVID-19 pandemic.

Apart from the behavioral intentions, it also needs to be asked whether consumers' attitudes, subjective norms, perceived behavioral control, and perceptions of greenwashing in their decision-making process differ after the outbreak of COVID-19. Furthermore, do the effects of predictors on behavioral intention differ after the outbreak of COVID-19? In order to answer these questions, we further propose the following two hypotheses:

H7: The magnitudes of the studied predictors differ after the outbreak of the COVID-19 pandemic.

H8: The effects of predictors on behavioral intention to reduce the SUT application differ after the outbreak of the COVID-19 pandemic.

To sum up, a positive attitude, stronger subjective norms, higher perceived behavioral control, and the positive past behavior of a consumer are expected to reflect a greater intention to reduce the SUT usage. On the other hand, the positive perception of less environmentally-problematic alternatives, such as paper and bioplastic SUT, is likely to have a negative effect on consumers' intentions to reduce their SUT usage. Besides, consumers' intentions to reduce the SUT application is expected to be lower

and the magnitudes of associated predictors as well as their effects on behavioral intentions are expected to differ after the outbreak of the COVID-19 pandemic.

3. Method

3.1 Data collection

Two surveys were conducted in one of the authors' affiliated universities before and after the outbreak of COVID-19. The respondents were the college students. While focusing on college students may limit the external validity of the findings, they are a key demographic group who relatively relies on SUT. There are many small restaurants, stores, and food stands surrounding the campus in addition to those located within the university itself. It is common for students to take their foods and drinks away together with SUT and to have their breakfast and lunch in the classrooms. A large amount of single-use waste is generated each day on campus as a result. It is therefore important to understand students' intentions regarding SUT reduction. Besides, students are young and their intentions might be relatively malleable. Policies targeting this group could potentially be more impactful and with long-run benefits than those aimed at less adaptable user groups.

The first survey was conducted from December 30, 2019 to January 10, 2020, about two weeks prior to the end of the fall semester in 2019. A pilot survey that resulted in minor changes to the questionnaire preceded it. Samples, with stratified random sampling, were drawn from the university's seven main colleges based on the percentages of the numbers of college students within the population. After removing samples with incomplete responses, there remained 772 valid questionnaires from the first survey. The population and sample distributions are displayed in Table 1. The calculated χ^2 values show that the observed sample frequencies for the characteristics of college and gender, respectively, do not significantly differ from the expected population frequencies at the 5% level according to the goodness-of-fit tests.

Soon afterwards, on January 15, 2020, CDC-Taiwan added "severe pneumonia with novel pathogens" as category 5 of its communicable diseases. The general public in Taiwan became aware of the newly-spreading disease and was alerted when the first case was reported on January 21. During the winter vacation and the lunar new year, people's daily lives were negatively influenced on a large scale and a travel ban has been in operation ever since. The start of the 2020 spring semester was postponed for two weeks nationwide. The campus of the university used in this research, which was previously open to the general public, merely allowed staff and students wearing face masks and with normal temperature to enter. The restaurants on campus once again provided only SUT. People were required to maintain social distancing when eating inside.

About two weeks into the spring semester, from March 17 to 31, the second survey was conducted. The purpose was to study whether consumers' intentions to reduce the SUT application had differed after the outbreak of the pandemic. The samples were again drawn from the seven main colleges based on the percentages of the numbers of college students within the university population using stratified random sampling. The second survey resulted in 774 valid questionnaires. The population and sample distributions are also displayed in Table 1. The calculated χ^2 values show that the sample was representative of the population.

For the purposes of comparison, the questionnaires for both surveys are identical. Indicators for each construct are designed using five-point Likert scales, where 1 indicates "always/strongly agree" and 5 "never/strongly disagree". We also collect social demographic data including those related to gender, department, degree, whether attending environmental courses or not, being a member of environmental clubs or not, experiences of participating in environmental activities, and how they

obtain information associated with environmental protection. An overview of the demographic variables used in the two surveys is presented in Table 2.

Table 1. Distributions of populations and samples

		First survey		Second survey	
		Population	Observed sample size (N)	Population	Observed sample size (N)
	Total	21,434	772	20,486	774
College	Liberal Arts	2,443	94	2,339	86
	Science	1,307	38	1,226	35
	Engineering	5,036	195	4,770	187
	Business and Management	7,874	302	7,591	273
	Foreign Languages and Literature	3,503	97	3,385	150
	International Affairs	549	18	487	17
	Education	722	28	688	26
	χ^2 value (p value)	11.37 (0.08)		7.62 (0.27)	
Gender	Male	11,180	393	10,587	381
	Female	10,254	379	9,899	393
	χ^2 value (p value)	0.47 (0.49)		1.87 (0.17)	

Table 2. Summary of the demographic variables

		First survey (N=772)	Second survey (N=774)
Variables	**Categories**	**Percentage (%)**	**Percentage (%)**
College	Liberal Arts	12.2	11.1
	Science	4.9	4.5
	Engineering	25.3	24.2
	Business and Management	39.1	35.3
	Foreign Languages and Literatures	12.6	19.4
	International Affairs	2.3	2.2
	Education	3.6	3.4
Gender	Male	50.9	49.2
	Female	49.1	50.8
Degree	Bachelor	92.4	90.3
	Master	7.1	7.8
	PhD	0.5	1.9
Attending environmental course	Yes	42.9	33.3
	No	57.1	66.7
A member of environmental clubs	Yes	2.2	1.2
	No	97.8	98.8
Participation in environmental activities	Yes	23.2	20.8
	No	76.8	79.2
Obtaining environmental information	Yes	95.5	96.4
	No	4.5	3.6

Table 3 presents the descriptive statistics of the indicators for each construct. The sources from which the indicators are adapted are also displayed. Each reversely-coded indicator is marked and its recoded data is generated by 6 minus the value for the original survey data.

The constructs for attitude, subjective norms, perceived behavioral control, and past behavior are modeled based on a formative measurement model. The rationale is that a person's attitude towards the SUT application is usually formed by different concerns regarding convenience, health, and environmental protection. Besides, different sources of social pressure constitute the various aspects of subjective norms. Moreover, SUT like spoons, forks, chopsticks, straws and containers possess different degrees of convenience and irreplaceability in the minds of users. Due to the multifaceted features of the above constructs, they are specified formatively. Doing so may also allow us to identify the most important drivers of each construct (Diamantopoulos and Winklhofer, 2001; Hair et al., 2017b).

The constructs greenwashing and intentions are modeled based on reflective measurement models. When a consumer is greenwashed, he/she will consider various kinds of SUT to be environmentally friendly if they are compostable and/or recyclable. Therefore, we specify greenwashing as a reflective construct. That is, greenwashing is a trait that explains the indicators and the indicators represent consequences (Fornell and Bookstein, 1982; Rossiter, 2002). Similarly, there is causal priority between the intention construct and its indicators. A consumer with a higher intention to reduce the SUT usage will be more willing to decrease his/her use of various kinds of SUT like straws, forks, or carrying bags, etc. In addition, it is appropriate to specify the intention construct as a reflective measurement model because the intention construct is an endogenous variable in the structural model (Wold, 1980; Chin, 1998).

3.2 Model estimation

In order to study the relationships among the latent variables, which are indirectly measured by indicators, in the extended TPB research framework, structural equation modeling (SEM) is specified. We perform the model estimation by adopting the partial least squares structural equation modeling (PLS-SEM) approach. Multiple regression is inappropriate because it uses sum scores or mean value for a latent variable, which assumes an equal weighting of indicators. Ignoring differences in the individual item weights gives rise to substantial biases in the parameter estimates (Hair et al., 2017a; Hair et al., 2017b). In addition, PLS-SEM, instead of the covariance-based SEM (CB-SEM), is used because we wish to explore which independent variables are key predictors of the intention to reduce SUT, as well as to point out which indicators are important drivers. The incorporation of both reflective and formative measurement models also leads to the choice of PLS-SEM (Hair et al., 2017b). Since PLS-SEM is a nonparametric method, 5,000 bootstrap samples (randomly drawn with replacement from the original dataset) are used to test the significance of the model coefficients. The software of SmartPLS 3 is applied to perform the estimation.

4. Results

In this section, we first assess the measurement qualities for both the reflective and formative measurement models. Next, the structural model estimates are evaluated and the hypotheses are also tested.

Table 3. Constructs and indicators of the extended TPB model

Constructs		Indicators	Mean[1] (s.d.)	Mean[2] (s.d.)	Adapted from (Sources)
Attitude (ATT)	att1[3]:	In your opinion, reducing the application of SUT is contributing to environmental protection.	4.37 (0.75)	4.35 (0.72)	Sun et al. (2017), Khan et al. (2019), Ertz et al. (2017)
	att2[3]:	Generally speaking, how much do you care for the environment?	3.87 (0.62)	3.81 (0.58)	
	att3:	In your opinion, applying SUT is beneficial to your health.	3.36 (1.27)	3.22 (1.09)	
	att4:	In your opinion, it is important to obtain the convenience of applying SUT.	2.32 (0.94)	2.34 (0.90)	
	att5:	You would like to obtain unsolicited SUT for take-away food.	2.89 (1.05)	2.89 (1.02)	
	att6:	In your opinion, diners should pack the food in carrying bags for customers.	2.74 (0.96)	2.69 (0.91)	
	att7[3]:	Do you endorse diners replacing SUT with reusable tableware for eat-in customers?	4.31 (0.78)	4.09 (0.86)	
Subjective norms (SN)	sn1[3]:	Your close friends consider that you should bring your own tableware when dining out.	3.13 (0.88)	3.06 (0.87)	Sun et al. (2017), Khan et al. (2019), Ertz et al. (2017)
	sn2[3]:	Your family members consider that you should bring your own tableware when dining out.	3.31 (0.91)	3.35 (0.91)	
	sn3[3]:	Government policies (e.g., bans on free plastic carrying bags, and on plastic straws) are helpful for you to reduce the SUT application.	3.95 (0.97)	4.00 (0.90)	
	sn4[3]:	Being aware that animals, such as sea turtles, might be harmed by discarded SUT is helpful for you in reducing the SUT application.	4.08 (0.85)	4.07 (0.80)	
	sn5[3]:	University regulations in diners and cafés on campus (e.g., a ban on offering free chopsticks and free carrying bags, and not offering unsolicited straws) is helpful to you in reducing the SUT application.	4.04 (0.88)	4.07 (0.80)	
Perceived behavioral control (PBC)	pbc1:	It is difficult for you to drink a beverage without using a single-use straw.	2.66 (1.19)	2.70 (1.14)	Sun et al. (2017), Khan et al. (2019), Ertz et al. (2017)
	pbc2[3]:	It is easy for you to bring your own cup or water bottle when going out.	3.14 (1.14)	3.13 (1.11)	
	pbc3[3]:	It is easy for you to bring your own cutlery when dining out.	3.03 (1.05)	3.05 (1.04)	
	pbc4:	It is difficult for you to bring your own containers when dining out.	2.45 (0.98)	2.44 (0.95)	
	pbc5:	It is difficult for you not to use carrying bags offered by the diner to pack food.	2.74 (1.07)	2.70 (1.01)	
Past behavior (PB)	pb1:	Do you often use single-use straws to drink beverages?	2.30 (1.05)	2.41 (1.05)	Knussen et al. (2004), Pakpour et al. (2014)
	pb2[3]:	Do you often bring your own cup or water bottle when going out?	2.54 (1.34)	2.58 (1.32)	
	pb3[3]:	Do you often bring your own cutlery when dining out?	2.43 (1.19)	2.40 (1.13)	
	pb4:	Do you often use carrying bags offered by diners to pack food?	2.52 (0.99)	2.54 (0.99)	
	pb5[3]:	Do you re-use the plastic bags that you pay for?	3.39 (1.20)	3.52 (1.13)	
Green-washing (GW)	gw1[3]:	Paper tableware is environmentally friendly because it can be recycled.	3.73 (1.01)	3.75 (0.98)	Lindh et al. (2016)
	gw2[3]:	Plastic tableware with a recycling mark is environmentally friendly because it can be recycled.	3.91 (0.93)	3.92 (0.87)	
	gw3[3]:	Biodegradable plastic bags are environmentally friendly.	4.05 (0.86)	4.02 (0.86)	
	gw4[3]:	Rice straw-based disposable chopsticks are more environmentally friendly than disposable bamboo chopsticks.	3.85 (0.89)	3.82 (0.86)	
Intention (BI)	int1[3]:	Are you willing to abandon the application of single-use straws when drinking beverages?	3.79 (1.09)	3.82 (1.05)	Sun et al. (2017), Khan et al. (2019), Ertz et al. (2017)
	int2[3]:	Are you willing to bring your own cup or water bottle when going out?	3.75 (1.01)	3.76 (1.03)	
	int3[3]:	Are you willing to bring your own cutlery when dining out?	3.70 (1.02)	3.73 (1.00)	
	int4[3]:	Are you willing to use your own reusable containers or bowls to pack takeout food?	3.37 (1.06)	3.40 (1.05)	
	int5[3]:	Are you willing to abandon the application of carrying bags offered by diners to pack food?	3.88 (1.01)	3.91 (0.98)	

Note: [1] Figures for the first survey. [2] Figures for the second survey. [3] These indicators are recoded.

4.1 Measurement model

4.1.1 Assessment of the reflective construct

The constructs greenwashing and intention are specified reflectively. We examine the criteria for indicator reliability, internal consistency reliability, convergent validity, and discriminant validity for these two constructs.

First, indicator reliability is evaluated by the size of the indicator's outer loading. For the estimates of both survey samples, we find that all outer loadings of the intention construct are well above the threshold value of 0.7. However, this is not the case for the greenwashing construct. The outer loading of indicator gw1 is only 0.199 for the second survey sample, which is too low for gw1 to be retained in the construct. We thus eliminate the item. Table 4 shows the estimates of the measurement models for the first and second survey samples after the elimination. Among the three indicators related to the greenwashing construct, the outer loadings for two of the indicators are above 0.7 and that for the other lies between 0.6 and 0.7. Taking into consideration the content validity, we retain all three indicators for the greenwashing construct (Hair et al., 2017b).

Second, the values of Cronbach's alpha for the greenwashing and intention constructs are 0.704 (0.721) and 0.855 (0.859), respectively, for the first (second) survey sample. The values of composite reliability for the greenwashing and intention constructs are 0.795 (0.815) and 0.896 (0.899), respectively, for the first (second) survey sample. The above values, all greater than 0.7, imply that the internal consistency reliabilities of the greenwashing and intention constructs for both survey samples are satisfactory.

Third, to meet convergent validity, the values of the average variance extracted (AVE) should be greater than 0.5. Here, the AVE values of the greenwashing and intention constructs are 0.569 (0.601) and 0.634 (0.640), respectively, for the first (second) survey sample. The convergent validities of these two constructs are met.

Finally, we examine the discriminant validity according to the HTMT criterion (Heterotrait-Monotrait Ratio, Henseler et al. 2015). The HTMT values for the pair of intention and greenwashing constructs are 0.057 and 0.103 for the first and second survey samples, respectively. Both of them are far below the more conservative threshold value of 0.85. Moreover, these HTMT ratios are significantly different from 1 according to the 95% (bias-corrected and accelerated) bootstrap confidence intervals ([0.029, 0.073] and [0.054, 0.164] for the first and second samples, respectively). The discriminant validity of the intention and greenwashing constructs are supported. In addition, the cross-loadings and the Fornell-Larcker criterion also suggest that the discriminant validity for both constructs is established although we do not present the results to maintain brevity.

4.1.2 Assessment of the formative constructs

To evaluate a formative measurement model, we first assess whether there is a potential collinearity problem among the indicators. Then, the significance and relevance of the indicators are examined. Table 5 presents the values of the outer VIF (variance inflation factor) for all formative constructs. It can be seen that every VIF value is lower than the threshold value of 5. Therefore, collinearity is not an issue for all of the formative constructs.

As for the significance of the outer weights (see Table 4), all formative indicators are significant at the 5% level, except for att3 and att7 for the attitude construct. Since the outer loadings of these two indicators are also less than 0.5, we remove them from the model. The other five significant indicators are retained to form the attitude construct.

Table 4. Coefficient estimates of the measurement models

Constructs	Indicators	First survey		Second survey	
		Outer loadings (*p*-value)	Outer weights (*p*-value)	Outer loadings (*p*-value)	Outer weights (*p*-value)
BI	int1	0.807 (0.000)		0.793 (0.000)	
	int2	0.790 (0.000)		0.782 (0.000)	
	int3	0.840 (0.000)		0.863 (0.000)	
	int4	0.822 (0.000)		0.813 (0.000)	
	int5	0.717 (0.000)		0.746 (0.000)	
ATT	att1		0.427 (0.000)		0.403 (0.000)
	att2		0.236 (0.000)		0.384 (0.000)
	att4		0.363 (0.000)		0.318 (0.000)
	att5		0.244 (0.001)		0.172 (0.008)
	att6		0.235 (0.001)		0.244 (0.000)
SN	sn1		0.153 (0.015)		0.290 (0.000)
	sn2		0.226 (0.001)		0.202 (0.001)
	sn3		0.178 (0.011)		0.126 (0.079)
	sn4		0.419 (0.000)		0.568 (0.000)
	sn5		0.417 (0.000)		0.253 (0.000)
PBC	pbc1		0.238 (0.000)		0.271 (0.000)
	pbc2		0.272 (0.000)		0.369 (0.000)
	pbc3		0.518 (0.000)		0.515 (0.000)
	pbc4		0.146 (0.001)		0.138 (0.001)
	pbc5		0.230 (0.000)		0.128 (0.002)
PB	pb1		0.503 (0.000)		0.500 (0.000)
	pb2		0.390 (0.000)		0.304 (0.000)
	pb3		0.336 (0.000)		0.452 (0.000)
	pb4		0.319 (0.000)		0.182 (0.030)
	pb5		0.301 (0.000)		0.313 (0.000)
GW	gw2	0.790 (0.007)		0.652 (0.002)	
	gw3	0.604 (0.062)		0.716 (0.000)	
	gw4	0.847 (0.008)		0.929 (0.000)	

Table 5. VIF values

Constructs	Indicators	VIF values	
		First survey	Second survey
ATT	att1	1.389	1.308
	att2	1.251	1.213
	att3	1.125	1.131
	att4	1.379	1.418
	att5	1.866	1.752
	att6	1.668	1.463
	att7	1.205	1.109
SN	sn1	1.574	1.336
	sn2	1.587	1.323
	sn3	1.668	1.630
	sn4	1.536	1.401
	sn5	1.865	1.820
PBC	pbc1	1.402	1.312
	pbc2	1.525	1.349
	pbc3	1.547	1.433
	pbc4	1.280	1.272
	pbc5	1.351	1.360
PB	pb1	1.065	1.088
	pb2	1.227	1.276
	pb3	1.220	1.282
	pb4	1.053	1.072
	Pb5	1.021	1.017
GW	gw2	1.492	1.422
	gw3	1.598	1.520
	gw4	1.240	1.349

4.2 Structural model

First, we check the collinearity issue by examining the VIF values of all predictor constructs in the structural model. It is shown that the VIF values for the ATT, SN, PBC, PB, and GW constructs are 1.767 (1.746), 1.585 (1.556), 1.775 (1.764), 1.488 (1.427), and 1.088 (1.025), respectively, for the first (second) survey sample. Since they are all below the threshold of 5, collinearity among the predictor constructs is not a problem in the structural model.

Second, the estimated results of the structural model are shown in the second and third columns in Table 6. All predictor constructs positively affect the consumers' reduction intentions and are significant at the 5% level, except that PB and GW are not significant for the first-survey structural model.

The adjusted coefficient of determination (R^2_{adj}) is 0.597 (0.602) for the first- (second-) survey structural model. The amount of the variance in the endogenous intention construct explained by the exogenous constructs is considered to be moderate. The f^2 effect size of the individual construct ATT, SN, PBC, PB, and GW on intention is 0.037 (0.093), 0.147 (0.067), 0.269 (0.268), 0.003 (0.007), and 0.002 (0.017) for the first- (second-) survey structural model. The predictor constructs of the original TPB model (ATT, SN, and PBC) all have effects on the endogenous intention construct, while the low values of the f^2 effect size (less than 0.02) for PB and GW show that the omission of PB or GW has hardly any impact on the model's R^2 value. The Q^2 measure of the model's out-of-sample predictive power is 0.372 for the first-survey model, and 0.381 for the second. The Q^2 measure, which is larger than 0, means that the model has predictive relevance for the endogenous intention construct.

Overall, the above results show that hypotheses H1-H3, specified in the original TPB, are significantly supported. Hypothesis H4 that associates with past behavior is only supported in the second survey. Hypothesis H5 that incorporate greenwashing is nonetheless not supported in both surveys.

4.3 Before vs. after COVID-19 outbreak

Based on the two surveys conducted before and after the outbreak of COVID-19, we first examine whether the construct means significantly changed after the outbreak of COVID-19 by using the independent samples t test. We then perform a multigroup analysis to determine whether the model effects (path coefficients) changed significantly after the outbreak of the pandemic.

The results of the independent samples t test are displayed in Table 7. It can be seen that the means of each construct before and after the outbreak of COVID-19 are not significantly different at the 5% significance level, except for the construct ATT. The mean value for the attitude towards reducing the SUT application significantly decreased after the outbreak of COVID-19.

Table 6. Estimates of path coefficients and the permutation test

	Path coefficients of the *first-survey group* (*p*-value)	**Path coefficients of the *second-survey group* (*p*-value)**	**Path coefficients *difference*[1] (permutation *p*-value)**
ATT → BI	0.161 (0.000)	0.254 (0.000)	-0.093 (0.043)
SN → BI	0.305 (0.000)	0.203 (0.000)	0.102 (0.018)
PBC → BI	0.437 (0.000)	0.432 (0.000)	0.005 (0.918)
PB → BI	0.041 (0.169)	0.063 (0.028)	-0.021 (0.598)
GW → BI	0.029 (0.337)	0.082 (0.011)	-0.053 (0.119)

Note: [1] The path coefficients difference is calculated by subtracting the path coefficient of the second-survey group from the one of the first-survey group.

Table 7. Construct means and the independent samples t test

Construct	COVID-19	N	Mean	Mean difference[1]	*t*	*p*-value
ATT	Before	772	3.409	0.067	2.506[2]	0.012
	After	774	3.342			
SN	Before	772	3.701	-0.010	-0.325[2]	0.745
	After	774	3.711			
PBC	Before	772	2.806	0.001	0.028	0.977
	After	774	2.805			
PB	Before	772	2.638	-0.052	-1.661	0.097
	After	774	2.690			
GW	Before	772	3.887	0.010	0.290	0.772
	After	774	3.877			
BI	Before	772	3.698	-0.025	-0.586	0.558
	After	774	3.722			

Note: [1] The mean difference is calculated by subtracting the mean of the after-group from the mean of the before-group.

[2] The Welch t Test statistic (the assumption of homogeneity of variance is rejected by Levene's test).

In order to proceed with a multigroup analysis, partial measurement invariance between the two survey groups should be established, otherwise group comparisons can be misleading (Hair et al., 2017b). We applied the measurement invariance of composite models (MICOM) procedure, proposed by Henseler et al. (2016), to analyze the measurement invariance.

First, we ensured that configural variance exists across the groups. That is, the PLS path models, the data treatment, and the algorithm settings are ensured to be identical for both groups. Second, we tested the correlation between the composite scores of the first and second groups with 1,000 permutations. The original correlation values for the constructs BI, ATT, SN, PBC, PB, and GW are 1.000 (0.562), 0.988 (0.367), 0.978 (0.122), 0.993 (0.308), 0.984 (0.658), and 0.958 (0.770), respectively (the permutation p-values are in the parentheses). Since all the permutation p-values are larger than 0.05, the original correlation between the composite scores of the first and second groups for each construct is not significantly different from 1. This result supports the existence of compositional invariance for each construct. As both configural invariance and compositional invariance are established for all constructs, there is partial measurement invariance. We can thus compare the path coefficients across the groups by means of a multigroup analysis.

The permutation test, with advantageous statistical properties, is recommended to examine the results of the multigroup analysis (Hair et al., 2017b; Hair et al., 2018). The test results are displayed in the last column of Table 6. It can be seen that the relationships between attitude and intention as well as subjective norms and intention differ significantly at the 5% level before and after the outbreak of COVID-19. The relationships between the other three constructs and intention do not differ significantly, however.

To sum up, hypothesis H6 is not supported. That is, consumers' intentions to reduce the SUT application is not found to be lower after the outbreak of the COVID-19 pandemic. Hypothesis H7 is, however, partially supported. While the other predictors do not differ before and after the outbreak, consumers' average attitude is seen to significantly decline after the outbreak. Hypothesis H8 is also partially supported. The effect of attitude on intention increases, while that of subjective norms on intention decreases after the outbreak. The effect of the other three constructs on intention, respectively, does not differ significantly.

5. Discussion

This article aims to shed some light on consumers' intentions to reduce the SUT facing a public health crisis like COVID-19. The mean value of consumers' intentions to reduce SUT after (3.722) the outbreak of COVID-19 is higher than that of before (3.698), but shows no statistical difference based on the independent samples t test. Since the application of single-use materials sharply increased after the outbreak of COVID-19, this result might be contrary to our instincts. However, even if public hygiene retains its top priority under the pandemic, the above results show that consumers' willingness to reduce SUT is not necessarily compromised. There are four plausible explanations.

First, SUT is usually displayed in an open space with mostly free access. This poses risks. Although applying SUT is considered to be exempt from the likelihood of cross-contamination, consumers may be concerned that SUT or its packages might be touched by others. Second, consumers could be more in control of the cleanliness and safety of the reusable tableware prepared by themselves. Therefore, using one's own reusable tableware, with proper cleaning, may be even safer. Third, self-reporting surveys usually have the problem of behavior-intention gap (cf., Chang and Hung, 2023). Respondents' pro-environmental claims may differ from their actual behavior mainly due to social desirability bias, barriers to action, or prioritization of ethical concerns (Carrington et al., 2014; ElHaffar et al., 2020). Lastly, although the post-survey was conducted after the outbreak, Taiwan had not yet experienced a large number of COVID-19 cases at that time. Respondents' intentions of our two surveys might thus not significantly differ.

The insignificant change in respondents' intentions to reduce SUT suggests that policies that largely rely on (re)introducing SUT for safety reasons seem to lack a comprehensive consideration. First, SUT is not as clean as thought for the public health in a pandemic. Like mentioned above, SUT is usually displayed in an open space with mostly free access and SUT or its packages might usually be touched by others. With the encouragement of policy, however, the consumption of single-use materials expands and even to encompass packaging. In addition, it is observed that the mean values of individual items of the intention construct are all higher for the second survey. This shows that consumers are more willing to bring their own tableware or reduce the uses of single-use straws and carrying bags offered by diners after the outbreak of COVID-19. Hence, advocating the use of one's own reusable tableware during a pandemic, instead of only encouraging the disposable variety, may possibly mitigate both the hygiene-related problems and the environmental hazards.

Second, although some studies express environmental concerns about the increasing SUPs application during the pandemic, most of them resort to other single-use alternatives like bioplastics or emphasize the recyclability of food packaging (Silva et al., 2021; Vanapalli et al., 2021; Parashar and Hait, 2021). Nevertheless, using single-use alternatives still cause environmental and resource problems. The situations might be worse if the rebound effect happens.

Among the five predictor constructs, perceived behavioral control (PBC) influences consumers' intentions to reduce SUT the most, while the indicator pbc3 (i.e., it is easy for you to bring your own cutlery when dining out) plays the most important driver in this construct. In addition, no statistical difference is found in the PBC construct means or path coefficients when comparing the pre- and post-outbreak periods. These outcomes suggest that the best way to motivate consumers to reduce their SUT usage, even during a public health crisis, would be to enhance the consumers' confidence and capability in preparing and using reusable tableware or merely refusing SUT application. This finding is consistent with that on recycling electronic waste (Echegaray and Hansstein, 2017) and applying reusable products (Ertz et al., 2017). A consumer's PBC may benefit from policy measures such as promoting an inviting environment for reusable tableware, offering economic incentives, or a combination of both. For instance, He et al. (2023) demonstrate that changing the default of cutlery choice to "no cutlery" and rewarding consumers with "green points" increase the share of no-cutlery orders for online food delivery. In addition, encouraging consumers to share their knowledge and

experiences with others on how to prepare their own tableware efficiently, recommending the use of disinfection devices, such as UV disinfection boxes that are installed in diners/cafés/restaurants for convenience, and encouraging producers to provide convenient but non-single-use substitutes may also work.

The subjective norms (SN) construct represents the secondary significant predictor for the consumers' intention to reduce SUT in the pre-pandemic survey. SN is also found a significant influencing factor for the intention of purchasing recycled and upcycled fashion products in Park and Lin (2020), recycling electronic waste (Echegaray and Hansstein, 2017) and applying reusable products (Ertz et al., 2017). Although the construct means do not differ significantly, the construct's path coefficients on BI are significantly different. It is lower but remains significant after the outbreak. The reason behind this is very likely to be related to the suspension of the ban on SUT imposed by the government and the university following the outbreak of COVID-19. In addition, the indicator sn4, being aware of the impact on animals, is the most important driver for the SN construct.

The mean value of the attitude (ATT) construct appears to be significantly lower after the outbreak. It seems that the worry over disease transmission plays a role in offsetting the concern to reduce the SUT to protect the environment. Consumers as a result become more reluctant to apply reusable tableware. The effect of ATT on BI appears to be significantly higher after the outbreak, however. The order of effect magnitude of ATT on BI and that of SN on BI switches in the post-outbreak survey. The possible explanation is that when hygiene and safety are considered to be a top priority after the outbreak, consumers' own attitudes become more effective than others' opinions. In addition, the regulation that suspends SUT also weakens subjective norms.

With respect to the extended constructs of PB and GW, the magnitudes of their construct means and path coefficients exhibit no significant differences before and after the outbreak according to the results of the independent samples t test and permutation test, respectively. However, both path coefficients become significant after the outbreak of the pandemic. The support of H4 after the outbreak shows the effect of a good habit on reducing SUT during the public health crisis.

On the other hand, the result does not support H5. Even though a high level of average GW is found (approximately 3.88), the single-use characteristic is not ignored by these consumers. That is, consumers might consider alternatives like bioplastics and paper to be more environmentally friendly materials, but their intentions to reduce the SUT usage remain strong. However, it could be a result that our survey respondents are college students who often possess a higher-level environmental knowledge than the general public. In any case, the government should pronouncedly advocate the single-use characteristic of the SUT alternatives in order to prevent greenwashing and the related rebound effects.

6. Conclusions

This article explores the issue of SUT, which is strongly related to hygienic concerns. Consumers' intentions to reduce their SUT usage exhibit no statistical difference between the pre- and post-COVID-19 outbreak periods. This result implies that while the world remains under the threat of the COVID-19 pandemic, consumers are still willing to make efforts to combat single-use materials.

The hypotheses specified in the conventional TPB are supported. A consumer's attitude, subjective norms, and perceived behavioral control significantly increase his/her intention to reduce the SUT application. In particular, the construct of perceived behavioral control serves as the most influential factor, both before and after the outbreak. The EPA and those advocating a reduction in single-use materials may propose ways to enhance the ability of consumers to avoid the SUT usage, including reusable tableware in cafés and diners, no-SUT as a default setting for take-away orders, or to replace

SUT with consumers' own reusable tableware. The promotion of the consumers' perceived behavioral control, subjective norms, or attitudes can mitigate the possible wastage of resources and environment-related disasters brought about by the pandemic.

The newly-added constructs of past behavior is only found influential on reduction intentions after the outbreak of the pandemic. The effect of greenwashing is nonetheless not found. Their implications in terms of reducing the SUT application could be positive. Consumers might consider alternatives like bioplastics and paper to be more environmentally friendly materials, but their intentions to reduce the SUT usage remain unaffected. On the other hand, whether consumers have managed to reduce their SUT application or not in the past becomes influential on their intentions to take reduction action during a public health crisis.

Finally, college-student samples, despite of being potentially impactful and with long-run benefits, might lead to biases in terms of age range, education, income group, as well as lifestyles if we apply the results to the general public. In addition, the two surveys were conducted in two consecutive semesters. We therefore do not know whether the consumers' intentions and other latent variables are changing as time goes by. Moreover, this article focuses on consumers' perspectives while providers' viewpoints, which also play a predominant role in reducing SUT, remain unexamined. For example, the cleanliness of the reusable tableware prepared by consumers may be a cause for concern to the food providers in small eateries and diners. The above limitations of the data and perspectives should be taken into account when conducting future research.

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