American Journal of Environmental Economics (AJEE)

ISSN: 2833-7905 (ONLINE)

VOLUME 5 ISSUE 1 (2026)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Environmental Economics (AJEE)

Volume 5 Issue 1, Year 2026
ISSN: 2833-7905 (Online)
DOI: https://doi.org/10.54536/ajee.v5i1.6731
https://journals.e-palli.com/home/index.php/ajee

Towards Sustainability: What Drives Female College Students' Intention to Adopt Menstrual Cups- A PLS SEM NCA Approach

Vineesh A K[1*], Ms. Arsha Anilkumar[2]

Article Information

Received: November 02, 2025

Accepted: January 18, 2026

Published: May 06, 2026

Keywords

Menstrual Cups, Sustainability, Theory of Planned Behaviour, Usage Intention

ABSTRACT

This study investigated the effect of various drivers on female students' menstrual cup usage intention using an extended TPB framework. Environmental concern and perceived benefits were considered as additional variables. A sample of 258 female respondents was collected using a quantitative, cross-sectional, convenient sampling strategy. The data were analysed using the PLS-SEM technique with the NCA approach. The results demonstrate that attitudes, perceived behavioural control, environmental concern, and perceived benefits positively influence female students' menstrual cup usage intentions. However, subjective norms did not have a positive impact on usage intention. Additionally, the NCA results confirmed that attitude and perceived benefits are essential for achieving the desired outcomes. This study explored the effects of various dimensions of usage intention for menstrual cups using an integrated PLS SEM-NCA approach. The outcomes of this study contribute to sustainable consumption behaviour, both theoretically and practically. Therefore, policymakers, environmental authorities, marketers, practitioners, and other stakeholders can use this information to enhance the intention to use sustainable hygiene products.

INTRODUCTION

In response to the United Nations'sustainable development goals (SDGs), there has been significant growth in global consumption patterns of sustainable or environmentally friendly products, particularly among young people (United Nations, 2023: Yamane & Kaneko, 2021). This has led to scholarly attention on green products and their consumption across various disciplines (Talwar *et al.*, 2021). Despite the growing interest in sustainable consumption, there is a paucity of research on female preferences for personal hygiene products, particularly during menstruation (Ahuja & Singh, 2022).

Menstruation is a natural biological process that occurs regularly in women and lasts for 5 to 7 days (Kaur *et al.*, 2018). The widespread adoption of sanitary pads (Peter & Abhitha, 2021) has resulted severe disposability issues and has become a stunning burden on the environment (Blair *et al.*, 2022). Consequently, the usage of sustainable or environmental user-friendly menstrual cups has been popularised as the best substitute for conventional sanitary pads (Patel *et al.*, 2023). Moreover, it provides single-use alternative with a smaller ecological impact (Valentin & Hechanova, 2023) to combat plastic waste. In addition, women's health and personal hygiene are still considered private matters because of societal concerns (Shukla & Sanjeev, 2022) or social taboos (Meenakshi, 2020). Therefore, these myths and taboos about menstruation hinder the widespread adoption of feminine hygiene products (Poulose *et al.*, 2024).

Owing to the efforts of environmental authorities, marketers, and the government, a substantial number of women have begun adopting menstrual cups in recent years (Meenakshi, 2020). Nevertheless, recent research has indicated an increasing acknowledgment of user attitudes and intentions regarding sustainable personal hygienic products (Pednekar *et al.*, 2022). Although existing research has investigated the hygienic and social means of sustainable menstrual products (Ahuja & Singh, 2022; Ajith & Rasheed, 2024; Babbar & Garikipati, 2023; Meenakshi, 2020), their usage and adoption remain unexplored (Huang & Huang, 2020; Gharacheh *et al.*, 2021). Thus, there is a notable research gap in sustainable consumption, focusing on the various dimensions of users' behavioural intentions regarding menstrual cups. In this context, this study explores the drivers of user intention to adopt menstrual cups, targeting female college students. To examine the effects of various determinants of usage intention for menstrual cups, this study utilises the theoretical underpinnings of the extended Theory of Planned Behaviour (TPB) (Ajzen, 1991). Previous research (Ayikwa *et al.*, 2020; Shukla & Sanjeev, 2024) indicates that the TPB framework cannot sufficiently predict user behavioural intention. Accordingly, this study integrates environmental concerns (Hansen *et al.*, 2018; Lupindo *et al.*, 2024) and perceived benefits (Kolil & Achuthan, 2024) as additional variables into the core constructs of TPB to predict menstrual cup usage intention. Therefore, this study addresses the following research questions:

RQ1: What drives the intention to use menstrual cups among female college students?

RQ2: what are the necessary conditions for predicting female college students' intention in menstrual cups?

Theoretical Framework and Hypotheses Development

Theory of Planned Behaviour (TPB)

The TPB posits that individual behaviour can be explained

[1] Department of Commerce C K G M Govt college Perambra, Kozhikode -Kerala-India
[2] PG student, Department of Commerce C K G M Govt college Perambra, Kozhikode -Kerala-India
[*] Corresponding author's e-mail: vineeshckd81@gmail.com

by intention (Ajzen, 1991). Studies have contended that TPB can be utilised to validate user behavioural intentions in varied contexts (Park & Kwon, 2017; Yang & Kim, 2023). The TPB asserts that usage intention is predicted by an individual's attitude, subjective norms, and perceived behavioural control. In addition, the empirical validity of TPB in sustainable behavioural intentions (Sun *et al.*, 2022), including green consumption and the purchasing of organic foods (Testa *et al.*, 2021), has been recognised. Therefore, this study relied on the TPB framework to examine the various drivers of menstrual cup usage intention.

Dimensions of Menstrual Cups Usage Intention

According to Valentin and Hechanova (2023), perceived quality, attitudes, self-identity, and perceived behavioural control were the major dimensions for predicting menstrual cup usage intention. Perceived value, perceived health benefits, attitudes towards electronic word-of-mouth, and environmental attitudes can impact purchase intentions for sustainable menstrual cup products (Februadi *et al.*, 2022). Shukla *et al.* (2024) explored the various drivers of women's attitudes and consumption of menstrual cups through the lens of TPB. Furthermore, Huang and Huang (2020) found that sexual orientation, attitudes, subjective norms, and perceived behavioural control significantly influenced menstrual cup usage intention. Based on the above, this study proposes the various dimensions of usage intention in menstrual cups as: attitude (Prakash & Pathak, 2017; Valentin & Hechanova, 2023), subjective norms (Shukla & Sanjeev, 2024; Testa *et al.*, 2021), perceived behaviour control (Paul *et al.*, 2016; Zhuang *et al.*, 2021), environmental concern(Deng *et al.*, 2022; Liao *et al.*, 2020), and perceived benefits(Pednekar *et al.*, 2022; Pokhrel *et al.*, 2021).

Attitude

Attitude refers to the positive or negative evaluation of a specific behaviour (Ajzen, 1991). Shukla and Sanjeev (2024) observed that attitude has a mooring effect when predicting the switching intentions of reusable feminine hygiene products. Huang and Huang (2020) contended that female menstrual cups usage intention are significantly impacted by their attitude. In addition, a favourable perception of sustainable menstrual products cultivates a positive attitude among women which, in turn, influences their adoption (Ahuja & Singh, 2022). Existing studies (Nekmahmud *et al.*, 2022; Prakash & Pathak, 2017; Valentin & Hechanova, 2023; Zhuang *et al.*, 2021) confirm that attitude is instrumental in predicting the usage intentions of sustainable products. Therefore, individuals with favourable attitudes tend to demonstrate higher usage intention for sustainable products. In light of the above discussion, this study proposes the following hypotheses:

H1: Attitude Positively Influences Intention to Adopt Menstrual Cups

Subjective Norms

People often use a product when they perceive that those in their reference group or family hold positive views of it. Valentin and Hechanova (2023) observed that societal norms significantly influence women perceptions of using menstrual cups. Nekmahmud *et al.* (2022) argued that consumers decision to purchase sustainable products are heavily impacted by their referred social groups, peer influence, and other related social values. Furthermore, research has demonstrated that friends and relatives are more instrumental than medical professional advices in women decision to adopt personal hygiene products (Shukla & Sanjeev, 2024). However, studies (Deng *et al.*, 2022; Paul *et al.*, 2016) demonstrated inconsistent results on the linkage of subjective norms and menstrual cup user intention. The literature further shows (Pokhrel *et al.*, 2021; Prakash & Pathak, 2017; Shukla & Sanjeev, 2024; Testa *et al.*, 2021) that there is a strong association between social norms and usage intention in sustainable product consumption. Thus, we propose the following hypothesis:

H2: Subjective Norms Positively Influence Intention to Adopt Menstrual Cups

Perceived Behaviour Control

Perceived behavioural control (PBC) pertains to an individual's perception of the ease or difficulty of performing a task (Ajzen, 1991). It can also be viewed as a person's capability to hold resources with their opportunity to discharge an action. Xu *et al.* (2020) highlighted that users are more likely to consume eco-friendly products once they feel that they can manage external factors. Huang and Huang (2020) explored the menstrual cup usage intention among university students and found that there existed high perceived behaviour control under constraining conditions in menstrual cup usage. In contrast, the results were not confirmed under the facilitating conditions. The extant literature (Emekci, 2019; Paul *et al.*, 2016; Zhuang *et al.*, 2021) suggests that perceived behavioural control significantly influences users' behavioural intentions regarding green product adoption and usage. Based on the above information, we hypothesise that:

H3: Perceived Behaviour Control Positively Influences Intention to Adopt Menstrual Cups

Environmental Concern

Environmental concern encompasses individuals' apprehensions and readiness to address ecological issues (Kim & Lee, 2023). Over the years, environmental concerns have emerged as a vital component of environmental research and have significantly impacted consumer buying behaviour (Liao *et al.*, 2020). Young people are increasingly incorporating environmental considerations into their purchasing decisions. Ahmed *et al.* (2021) identified a strong linkage between environmental concerns and youth's purchase intentions in organic food products. Furthermore, Prakash and Pathak (2017) found that users' intention to purchase eco-friendly products

is significantly predicted by environmental concern and willingness to pay. Past studies (Deng *et al.*, 2022; Emekci, 2019; Zhuang *et al.*, 2021) have explored and empirically validated that environmental concern is instrumental in predicting consumer green buying behaviour. Given the alternative use of menstrual cups to mitigate the risk of microplastic pollution, this study examines the multifaceted dimensions of female users' overall readiness to adopt menstrual cups. Therefore, this study proposes the following hypothesis:

H4: Environmental Concern Positively Influence Intention to Adopt Menstrual Cups

Perceived Benefits

Perceived benefits encompass both functional and non-functional motives (Sheth, 1983). Shimul *et al.* (2022) observed that functional motives (composed of convenience, quality, and price) and non-functional motives (social and emotional needs) can impact user attitudes and intentions in green consumption (Shimul *et al.*, 2022). Studies (Pednekar *et al.*, 2022; Pokhrel *et al.*, 2021; Tu *et al.*, 2021; Valentin & Hechanova, 2023) have highlighted that health benefits, including enhanced leakage protection, practicality and accessibility, cost-effectiveness, and the facilitation of physical activities during menstruation, are the perceived benefits associated with menstrual cup usage. Additionally, Kambala *et al.* (2020) found that female students in academic settings demonstrated a positive perception of menstrual products because of their associated benefits. This was also confirmed by Akroush *et al.* (2019) in their study on user attitudes towards sustainable product adoption. Accordingly, we hypothesise that:

H5: Perceived Benefits Positively Influence Intention to Adopt Menstrual Cups

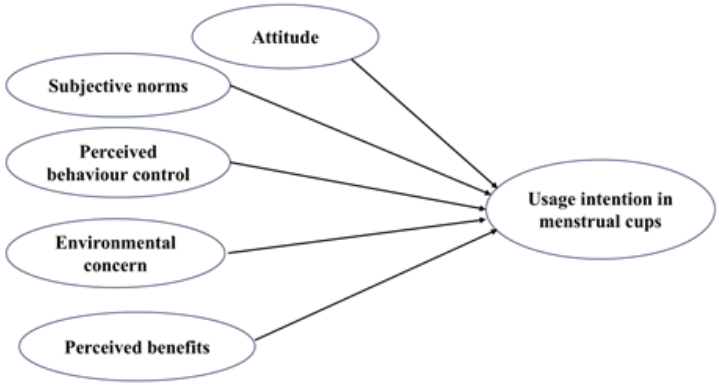

Figure 1: Research model proposed for the study

MATERIALS AND METHODS

Research Design and Data Collection

A survey-based quantitative research design was employed using a cross-sectional strategy to examine the various dimensions of female students' intention to adopt sustainable menstrual cups. The targeted population comprised both undergraduate and postgraduate female students in various arts and science colleges under the University of Calicut. Informed consent was obtained to comply with the ethical code of the study. Furthermore, the study utilised a convenience sampling approach to finalise the targeted group of respondents, focusing on college students aged 17–23 years. The data collection instrument was finalised after conducting a pilot study following the guidelines of Teare *et al.* (2014).

The survey instrument was designed and forwarded to female students WhatsApp groups with the support of women cell tutors in each college using Google Forms. Moreover, participants were offered the choice to keep their names confidential because of the sensitive nature of the research topic. Data were collected using online and offline survey methods. The targeted population comprised students pursuing programmes in the arts, science, and commerce disciplines. After discarding incomplete observations and outliers, a sample of 258 responses was analysed.

Instrument Development

The constructs were reflectively measured using items adapted to fit the specific research context of this study. Four items were adapted from Valentin and Hechanova (2023) to measure attitudes. Subjective norms were quantified using four indicators based on the studies of Lupindo *et al.* (2024) and Valentin and Hechanova (2023). Four indicators were modified from Carfora *et al.* (2019) to measure the construct of perceived behavioural control. Environmental concern was assessed using four indicators from Hansen *et al.* (2018). Moreover, the construct of perceived benefits was operationalised using four indicators adapted from Kolil and Achuthan (2024). Usage intention was measured using five items based on the studies by Chiu *et al.* (2019) and Valentin and Hechanova (2023). A five-point Likert scale was used to collect item responses ranging from 'strongly disagree' (1) to 'strongly agree' (5).

To check for common method bias, variance inflation factor (VIF) values were estimated, and the results demonstrated that all VIF values were below 3.3, indicating the absence of common method bias (Kock, 2017). The minimum sample size of 115 was estimated using G* Power software version 3.1.9.7 (Erdfelder *et al.*, 2009), with a statistical power of 0.80, including five predictors and an alpha level of 0.05. Given this,

the study included a total of 258 female participants. Furthermore, the causal relationships between the constructs were examined using SmartPLS software version 4.1.1.5, which is compatible with analysing complex models (Zeng *et al.*, 2021). A two-stage analysis (Hair *et al.*, 2019) was performed, comprising measurement model evaluation and structural model assessment (Becker *et al.*, 2023).

RESULTS AND DISCUSSIONS

Descriptive Analysis

The descriptive statistics details are presented in Table 1

Table 1: Demographic characteristics of respondents(N=258)

	Frequency	Percentage
Academic major		
UG	190	73.64
PG	68	26.36
Age groups		
17-19	19	07.36
19-21	163	63.17
21-23	72	27.91
Above 23	04	01.56
Most preferred menstrual products		
Menstrual cups	149	57.75
Sanitary pads	68	26.36
Menstrual panties	29	11.24
Others	12	04.65

Measurement Model Analysis

We followed the recommendations of Hair *et al.* (2022) to evaluate the reliability and validity criteria of the measurement model. To assess the model's reliability, item loadings and internal consistency scores were estimated. All the values of item loading (as shown in Table 2), with the exclusion of two items, met the suggested threshold of 0.7(Hair *et al.*, 2017). Additionally, Cronbach's alpha values and composite reliability scores were estimated to establish internal consistency reliability. The results confirmed that both values surpassed the minimum suggested value of 0.7 (Hair *et al.*, 2022), indicating a high level of internal consistency.

Convergent validity was assessed using average variance

Table 2: Measurement Model Results

Components	Items	Loadings	Composite Reliability	AVE	Cronbach's alpha
Attitude	ATT1	0.783	0.854	0.594	0.776
	ATT2	0.810			
	ATT3	0.743			
	ATT4	0.744			
Perceived behaviour control	PBC1	0.739	0.890	0.671	0.838
	PBC2	0.860			
	PBC3	0.841			
	PBC4	0.831			
Subjective norms	SN1	0.750	0.824	0.542	0.722
	SN2	0.711			
	SN3	0.858			
	SN4	0.604			
Environmental concern	EC1	0.775	0.870	0.626	0.805
	EC2	0.833			
	EC3	0.743			
	EC4	0.812			
Perceived benefits	PB1	0.843	0.841	0.572	0.755
	PB2	0.727			

	PB3	0.754			
	PB4	0.692			
Usage intention	UI1	0.719	0.875	0.585	0.722
	UI2	0.813			
	UI3	0.839			
	UI4	0.731			
	UI5	0.714			

extracted (AVE) values, and the results confirmed that all values were above the suggested criterion of 0.5(Hair *et al.*, 2022). The heterotrait-monotrait ratio of correlations (HTMT) values were estimated to evaluate the discriminant validity of the constructs, and the results (Table 3) indicated that all values were below the minimum threshold of 0.85(Henseler *et al.*, 2015). Consequently, discriminant validity was established in this study.

Structural Model Analysis

Structural model assessment encompasses multicollinearity checks, estimation of path coefficients, and the predictive capability of the research model (Hair *et al.*, 2019). A bootstrapping procedure of 10000 subsamples was employed to estimate the hypothesised relationships between the constructs (Hair *et al.*, 2022). The results are presented in Table 4. The relationship between attitude and usage intention was significant (β = 0.263, t = 4.513, p = .001), thereby supporting H1. Similarly, perceived behavioural control was significantly related to usage intention (β = 0.112, t = 2.497, p = .001), confirming H2. The hypothesised relationship between environmental concern and usage intention (β = 0.168, t = 3.608, p = .001) was also statistically significant, thereby supporting H4. Furthermore, perceived benefits were significantly associated with usage intention (β = 0.388, t = 6.229, p = .001), supporting H5. In contrast, the effect of subjective norms on usage intention (β = 0.057, t = 1.253, P = 0.210) did not show a positive association; therefore, H3 was rejected

Table 3: HTMT Ratio

Constructs	ATT	PBC	SN	EC	PB	UI
ATT	--					
PBC	0.115	--				
SN	0.114	0.172	--			
EC	0.157	0.240	0.083	--		
PB	0.651	0.200	0.151	0.171	--	
UI	0.604	0.275	0.167	0.333	0.694	--

Convergent validity was assessed using average variance extracted (AVE) values, and the results confirmed that all values were above the suggested criterion of 0.5(Hair *et al.*, 2022). The heterotrait-monotrait ratio of correlations (HTMT) values were estimated to evaluate the discriminant validity of the constructs, and the results (Table 3) indicated that all values were below the minimum threshold of 0.85(Henseler *et al.*, 2015). Consequently, discriminant validity was established in this study.

Structural Model Analysis

Structural model assessment encompasses multicollinearity checks, estimation of path coefficients, and the predictive capability of the research model (Hair *et al.*, 2019). A bootstrapping procedure of 10000 subsamples was employed to estimate the hypothesised relationships between the constructs (Hair *et al.*, 2022). The results are presented in Table 4. The relationship between attitude and usage intention was significant (β = 0.263, t = 4.513, p = .001), thereby supporting H1. Similarly, perceived behavioural control was significantly related to usage intention (β = 0.112, t = 2.497, p = .001), confirming H2. The hypothesised relationship between environmental concern and usage intention (β = 0.168, t = 3.608, p = .001) was also statistically significant, thereby supporting H4. Furthermore, perceived benefits were significantly associated with usage intention (β = 0.388, t = 6.229, p = .001), supporting H5. In contrast, the effect of subjective norms on usage intention (β = 0.057, t = 1.253, p = .001) did not show a positive association; therefore, H3 was rejected.

Table 4: Path coefficient estimates

Hypotheses	PATHS	β	T statistics	2.5% CI	97.5%CI	Results
H1	ATT -> UI	0.263	4.513	0.146	0.376	Accepted
H2	PBC -> UI	0.112	2.497	0.024	0.199	Accepted
H3	SN -> UI	0.057	1.253	-0.084	0.126	Rejected
H4	EC-> UI	0.168	3.608	0.070	0.253	Accepted
H5	PB-> UI	0.388	6.229	0.267	0.508	Accepted

Table 5: PLS predict assessment of Usage intention

Constructs	Items	Q^2 Predict	$RMSE_{PLS-SEM}$	$RMSE_{LM}$
Usage intention	UI1	0.277	0.761	0.745
	UI2	0.249	0.883	0.919
	UI3	0.220	0.823	0.822
	UI4	0.234	0.797	0.819
	UI5	0.176	0.807	0.849

To assess the predictive power of the research model, PLS predict procedure as suggested by Shmueli *et al.* (2019) was employed. Table 5 shows that all the root mean squared error (RMSE) values of the PLS-SEM model were lower than those of the linear model, demonstrating above moderate predictive capability. The model exhibited a robust R2 value of 0.436 (as shown in Table 6), indicating that 43.6 percent of the total variance in usage intention was predicted by attitude, perceived behaviour control, subjective norms, environmental concern, and perceived benefits. Consequently, the model has substantial explanatory power for the dependent variable.

Table 5: Co-efficient of Determination

Paths	R^2	Adjusted R^2
Usage Intention	0.436	0.424

Necessary Condition Analysis

Necessary Condition Analysis (NCA) was used to explore the necessary conditions for the usage intention of menstrual cups among female college students. Initially, the unstandardised latent variable scores of the PLS-SEM analysis were used as inputs to generate the NCA (Richter *et al.*, 2020) results. NCA suggests that a strong theoretical justification is required to establish the necessary conditions. Moreover, the effect size must be more than zero, followed by estimating the p-value (using a permutation test with a bootstrapping approach to determine the necessary conditions against the outcome) to confirm statistical significance (Dul, 2016; Dul *et al.*, 2023). This study employed the theoretical underpinning of TPB to establish the necessity logic among female students menstrual cup usage intention. Thus, the model posits that attitude, subjective norms, perceived behavioural control, environmental concern, and perceived benefits are essential conditions for predicting menstrual cup usage intention.

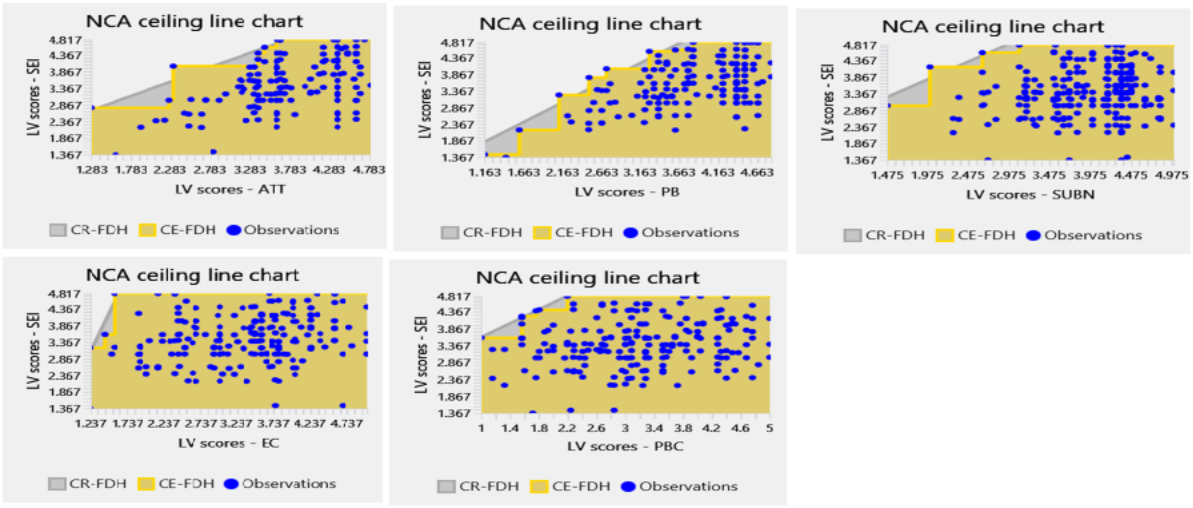

Figure 2:

The NCA procedure follows the estimation of potential outliers using scatter plots, which subsequently impacts the effect size calculation. The results of the scatter plots (fig. 1-5) confirmed that there were no potential outliers influencing the effect size calculation and hence, satisfied the criteria. NCA analysis also employs the Ceiling Regression–Free Disposal Hull (CR-FDH) technique(Toth & Dul, 2019), which is well-suited for both discrete and continuous data across various levels (Basco *et al.*, 2022). It is also suggested that the effect size value should be more than 0.1 at $p < 0.05$ level of significance to confirm the necessary conditions against the outcome variable (Dul, 2016). The findings(as shown in Table 7) indicated that attitude (d= 0.215, $p < 0.05$) and perceived benefits (d= 0.297, $p < 0.05$) were the necessary conditions for the usage intention of menstrual cups. However, perceived behaviour control (d = 0.052), subjective norms (d = 0.094), and environmental concern (d = 0.026) were not qualified as essential conditions.

Table 7: Ceiling line effect size

Dimensions	Usage intention	
	CR-FDH	P values
Attitude	0.215	0.000**
Perceived behaviour control	0.052	0.308
Subjective norms	0.094	0.484
Environmental concern	0.026	0.449
Perceived benefits	0.297	0.000**

Although perceived behavioural control and environmental concern exerted a statistically significant positive effect on usage intention within the structural model, they did not constitute a necessary condition in the NCA. Additionally, a bottleneck analysis was performed to highlight the combinations of minimum levels of attitude, subjective norms, perceived behavioural control, environmental concern, and perceived benefits required to obtain a specific level of usage intention for menstrual cups. A bottleneck analysis was performed to determine the necessary conditions(Toth & Dul, 2019) for different levels of usage intention for menstrual cup adoption. The results (Table 8) also revealed that to achieve a 40 % level of usage intention in menstrual cups, two conditions must be satisfied: at least 1.338 attitude and at least 1.936 perceived benefits. To achieve a 50% level of usage intention, three conditions must be satisfied: at least 1.736 attitude, at least 1.249 environmental concern, and at least 2.227 perceived benefits. Similarly, to achieve a higher level of usage intention (100 percent), five conditions must be satisfied: at least 3.738 attitude, at least 2.183 perceived behaviour control, at least 2.937 subjective norms, at least 1.612 environmental concern, and at least 3.682 perceived benefits. Consequently, the findings highlight the significance of attitude, subjective norms, perceived behavioural control, environmental concern, and perceived benefits in shaping female college students intentions to use menstrual cups.

Table 7: Bottleneck analysis: Usage Intention in Menstrual cups

	UI	ATT	PBC	SN	EC	PB
0%	1.367	NN	NN	NN	NN	NN
10%	1.712	NN	NN	NN	NN	NN
20%	2.057	NN	NN	NN	NN	1.354
30%	2.402	NN	NN	NN	NN	1.645
40%	2.747	1.338	NN	NN	NN	1.936
50%	3.092	1.736	NN	NN	1.249	2.227
60%	3.437	2.138	NN	1.643	1.321	2.518
70%	3.782	2.537	1.169	1.967	1.394	2.809
80%	4.127	2.938	1.507	2.29	1.467	3.100
90%	4.472	3.339	1.845	2.613	1.539	3.391
100%	4.817	3.738	2.183	2.937	1.612	3.682

Discussion

This study employs an extended TPB framework to explore the various drivers of usage intention among college students at the University of Calicut. First, a research model was proposed and later validated by integrating various dimensions of usage intention, such as attitude, subjective norms, perceived behaviour control, environmental concern, and perceived benefits. Using a quantitative cross-sectional strategy, the causal relationship between the constructs was examined by collecting data from a sample of 258 female respondents. PLS-SEM analysis was used to analyse the collected data. Furthermore, Necessary Condition Analysis was performed to determine the essential conditions for the intention to use menstrual cups. The results of the structural model assessment demonstrated that attitude, perceived behavioural control, environmental concern, and perceived benefits significantly impacted female college students' usage intention for menstrual cups. In addition, the outcomes of this study corroborate the majority of the proposed hypotheses and yield significant insights into the diverse factors influencing female students' intention to adopt sustainable menstrual cups.

Our results highlight a significant association between attitude and menstrual cups usage intention, which aligns the previous outcomes of (Ahuja & Singh, 2023; Februadi *et al.*, 2022; Huang & Huang, 2020; Shukla & Sanjeev, 2024: Valentin & Hechanova, 2023) who confirmed that positive attitude is instrumental in predicting female students' intentions to embrace menstrual cups.

Contrary to expectations, this study did not find a positive impact of subjective norms on the usage intention for

menstrual cups. These findings are consistent with those of Valentin and Hechanova (2023), who confirmed that the impact of friends, family, and relatives on the decision to embrace menstrual cups was inconsistent. This means that the adoption of menstrual cups challenges established traditional norms and, as a result, poses a threat to cultural ideals identified as social taboos (Meenakshi, 2020; Pokhrel *et al.*, 2021). Furthermore, our results demonstrated a significant positive association between perceived behaviour control and usage intention for menstrual cups, which is in line with the previous study of (Valentin & Hechanova, 2023) who suggested that students are confident in their decision to use menstrual products. However, Shukla *et al.* (2024) reported an insignificant association between perceived behavioural control and usage intention in green products consumption.

The results further confirmed the positive and significant impact of environmental concern on female students' menstrual cup usage intention. These outcomes align with the findings of Shukla *et al.* (2024) and Van Eijk *et al.* (2019), who suggested that using menstrual cups induces students to engage in pro-environmental behaviour. Recently, students are more inclined to substitute traditional sanitary products with sustainable menstrual products because they perceive it as a personal norm to mitigate environmental concerns to promote sustainability and societal well-being.

The findings of this study also showed a significant impact of perceived benefits on students intention to use menstrual cups. This implies that female students acknowledge that using menstrual cups contributes to ease of use, convenience, availability, enhanced leakage protection, comfort, economic and environmental benefits, and the capacity to engage in physical activities during menstruation. These results are in line with the outcomes of Hyttel *et al.* (2017), Pednekar *et al.* (2022), Pokhrel *et al.* (2021), and Valentin & Hechanova (2023).

Furthermore, the NCA results confirmed that both attitude and perceived benefits are essential conditions for achieving female students' intention to use menstrual cups. This indicates that female students are more inclined to adopt menstrual cups once they perceive a favourable evaluation along with acknowledging its perceived benefits. Additionally, bootstrapping analysis illustrated that perceived behavioural control and environmental concern were not essential conditions for predicting the outcome variables. Thus, this study underscores the significant role of attitude and perceived benefits in recognising female students intentions to use menstrual cups.

Implications

This research enhances the scholarly discourse on the sustainable consumption of female hygienic products, both theoretically and practically, by elucidating the various drivers of usage intentions for menstrual cups and identifying the necessary conditions for user adoption. Moreover, this study offers substantial contributions to the TPB framework by incorporating additional constructs, namely environmental concern and perceived benefits. The empirical validity of the extended TPB model was investigated by elucidating the various drivers of menstrual cup usage intention among female students at various affiliated colleges of the University of Calicut. Moreover, this study offers an integrated PLS-SEM NCA technique to expand its methodological contributions.

The results of the PLS SEM revealed the causal relationships between the constructs. However, NCA elucidated the necessary conditions for female students to yield the desired usage intention for menstrual cups. The study findings are further corroborated by the results of Necessary Condition Analysis, which indicates that favourable appraisal or evaluation of students towards menstrual cups and their associated benefits can serve as necessary conditions for user intentions. Therefore, without considering attitude and perceived benefits, other factors are inadequate in predicting menstrual cup usage intention. Moreover, this comprehensive research model can broaden the TPB framework across various contexts with a multidimensional perspective.

This study offers a comprehensive understanding of how various determinants contribute to the usage intention of menstrual cups among female students. Thus, it is useful for scholars, policymakers, and practitioners in the domain of sustainable consumption. The findings suggest that attitudes and perceived benefits are critical determinants of usage intention. This implies that marketing managers and institutions should prioritise both user attitudes and perceived benefits while developing their marketing mix. In addition, the findings of this study will also be helpful to various stakeholders, including health authorities, environmental management agencies, and other specific demographic groups, to promote sustainable consumption practices.

This research also enhances a comprehensive framework to promote the sustainable utilisation of female hygienic products, which is in line with the UN Sustainable Development Goals (United Nations, 2023). Additionally, the implementation of regular feedback systems and customer support facilities (Lathabhavan & Lathabhavan, 2024) can boost the quality of sustainable products, preferably among menstrual cup users.

Limitations and Scope for Future Research

This study also acknowledges its intrinsic limitations, which offer potential directions for future research. Given that the study is limited to a specific geographical area, broader generalisation of this topic across varied cultures and contexts remains unexplored. The study was also constrained by the inherent limitations of a cross-sectional survey. Therefore, future research can promote methodological advancements using longitudinal strategies to examine user behaviour intentions in sustainable personal hygiene products. This research also examined user intentions and behaviours concerning menstrual cups in varied contexts and regions through a

comprehensive research model. Moreover, future studies can incorporate varied theoretical models and variables and group-specific comparisons to provide more insights into sustainable consumption behaviours.

CONCLUSION

This study investigated the drivers of menstrual cup usage intention among female college students in various affiliated colleges under the University of Calicut. The study's outcomes suggest that associated product benefits and user attitudes are instrumental in sustainable consumption. Nevertheless, the impact of social norms is inconsistent in predicting female users' intentions to adopt menstrual cups. In addition, the findings highlighted the limited impact of perceived behavioural control on female menstrual cup usage intention. This would help various stakeholders, including marketers, practitioners, and health authorities, to develop more inclusive strategies to promote usage intention in female personal hygiene products. Overall, strict regulatory compliance from the government, quality standards, feedback mechanisms, and the provision of responsible after-sales services can facilitate sustainable consumption.

Conflict of Interest

Authors declare that no potential conflicts of interest regarding the publication of this article

Data Availability Statement

Data used for this study will be available based on request

REFERENCES

Ahmed, N., Li, C., Khan, A., Qalati, S. A., Naz, S., & Rana, F. (2021). Purchase intention toward organic food among young consumers using theory of planned behavior: role of environmental concerns and environmental awareness. *Journal of Environmental Planning and Management, 64*(5), 796-822. https://doi.org/10.1080/09640568.2020.1785404

Ahuja, P., & Singh, N. (2022). Sustainable menstrual products: the challenges ahead. *Asian Journal of Women's Studies, 28*(3), 397-411. https://doi.org/10.1080/12259276.2022.2098896

Ajith, N. T., & Rasheed, A. F. (2024). Investigating the switch from sanitary napkins to menstrual cups. *Journal of Cleaner Production, 452,* 142197. https://doi.org/10.1016/j.jclepro.2024.142197

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes, 50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Akroush, M. N., Zuriekat, M. I., Al Jabali, H. I., & Asfour, N. A. (2019). Determinants of purchasing intentions of energy-efficient products: The roles of energy awareness and perceived benefits. *International Journal of Energy Sector Management, 13*(1), 128-148. https://doi.org/10.1108/IJESM-05-2018-0009

Ayikwa, L. C., De Jager, J. W., & Van Zyl, D. (2020). Validating the theory of planned behavior model extended to social marketing behavioral enhancers using structural equation modeling. *Social Marketing Quarterly, 26*(4), 276-296. https://doi.org/10.1177/1524500420951593

Babbar, K., & Garikipati, S. (2023). What socio-demographic factors support disposable vs. sustainable menstrual choices? Evidence from India's National Family Health Survey-5. *Plos one, 18*(8), e0290350. https://doi.org/10.1371/journal.pone.0290350

Basco, R., Hair Jr, J. F., Ringle, C. M., & Sarstedt, M. (2022). Advancing family business research through modeling nonlinear relationships: Comparing PLS-SEM and multiple regression. *Journal of Family Business Strategy, 13*(3), 100457. https://doi.org/10.1016/j.jfbs.2021.100457

Becker, J. M., Cheah, J. H., Gholamzade, R., Ringle, C. M., & Sarstedt, M. (2023). PLS-SEM's most wanted guidance. *International Journal of Contemporary Hospitality Management, 35*(1), 321-346. https://doi.org/10.1108/IJCHM-04-2022-0474

Blair, L. A. G., Bajón-Fernández, Y., & Villa, R. (2022). An exploratory study of the impact and potential of menstrual hygiene management waste in the UK. *Cleaner Engineering and Technology, 7,* 100435. https://doi.org/10.1016/j.clet.2022.100435

Carfora, V., Cavallo, C., Caso, D., Del Giudice, T., De Devitiis, B., Viscecchia, R., ... & Cicia, G. (2019). Explaining consumer purchase behavior for organic milk: Including trust and green self-identity within the theory of planned behavior. *Food Quality and Preference, 76,* 1-9. https://doi.org/10.1016/j.foodqual.2019.03.006

Chiu, C. L., Wang, Q., Ho, H. C., Zhang, J., & Zhao, F. (2019). Metrosexual trend in facial care products: Analysis of factors that influence young Chinese men purchasing intention. *Journal of Global Fashion Marketing, 10*(4), 377-397. https://doi.org/10.1080/20932685.2019.1639527

Deng, L., Li, G., Peng, S., Wu, J., & Che, Y. (2022). Microplastics in personal care products: exploring public intention of usage by extending the theory of planned behaviour. *Science of the Total Environment, 848,* 157782. https://doi.org/10.1016/j.scitotenv.2022.157782

Dul, J. (2016). Necessary condition analysis (NCA) logic and methodology of "necessary but not sufficient" causality. *Organizational research methods, 19*(1), 10-52. https://doi.org/10.1177/1094428115584005

Dul, J., Hauff, S., & Bouncken, R. B. (2023). Necessary condition analysis (NCA): review of research topics and guidelines for good practice. *Review of Managerial Science, 17*(2), 683-714. https://doi.org/10.1007/s11846-023-00628-x

Emekci, S. (2019). Green consumption behaviours of consumers within the scope of TPB. *Journal of Consumer Marketing, 36*(3), 410-417. https://doi.org/10.1108/JCM-05-2018-2694

Erdfelder, E., FAul, F., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149–1160.

Februadi, A., Nabilah, A., & Najib, M. F. (2022). Determinants of attitudes toward green product and purchase intention of zero-waste product: A case study of menstrual cup. *Journal of Marketing Innovation, 2*(2), 44-56. http://doi.org/10.35313/jmi.v2i2.34

Gharacheh, M., Ranjbar, F., Hajinasab, N., & Haghani, S. (2021). Acceptability and safety of the menstrual cups among Iranian women: a cross-sectional study. *BMC Women's Health, 21*(1), 105. https://doi.org/10.1186/s12905-021-01259-8

Hair, J., & Alamer, A. (2022). Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example. *Research Methods in Applied Linguistics, 1*(3), 100027. https://doi.org/10.1016/j.rmal.2022.100027

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European business review, 31*(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203

Hansen, T., Sørensen, M. I., & Eriksen, M. L. R. (2018). How the interplay between consumer motivations and values influences organic food identity and behavior. *Food policy, 74,* 39-52. https://doi.org/10.1016/j.foodpol.2017.11.003

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the academy of marketing science, 43*(1), 115-135. https://doi.org/10.1007/s11747-014-0403-8

Huang, P. T., & Huang, J. H. (2020). Menstrual cup use intention and the moderating effects of sexual orientation and gender characteristic among female university students in Taiwan: a theory-driven exploration. *Archives of Sexual Behavior, 49*(4), 1355-1366. https://doi.org/10.1007/s10508-019-1412-y

Hyttel, M., Thomsen, C. F., Luff, B., Storrusten, H., Nyakato, V. N., & Tellier, M. (2017). Drivers and challenges to use of menstrual cups among schoolgirls in rural Uganda: a qualitative study. Waterlines, 109-124. https://www.jstor.org/stable/26600773

Kambala, C., Chinangwa, A., Chipeta, E., Torondel, B., & Morse, T. (2020). Acceptability of menstrual products interventions for menstrual hygiene management among women and girls in Malawi. *Reproductive health, 17*(1), 185. https://doi.org/10.1186/s12978-020-01045-z

Kaur, R., Kaur, K., & Kaur, R. (2018). Menstrual hygiene, management, and waste disposal: practices and challenges faced by girls/women of developing countries. *Journal of environmental and public health, 2018*(1), 1730964. https://doi.org/10.1155/2018/1730964

Kim, N., & Lee, K. (2023). Environmental consciousness, purchase intention, and actual purchase behavior of eco-friendly products: The moderating impact of situational context. *International Journal of Environmental Research and Public Health, 20*(7), 5312. https://doi.org/10.3390/ijerph20075312

Kock, N. (2017). Common method bias: a full collinearity assessment method for PLS-SEM. In *Partial least squares path modeling: Basic concepts, methodological issues and applications* (pp. 245-257). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-64069-3_11

Kolil, V. K., & Achuthan, K. (2024). Development and validation of a survey instrument for reusable sanitary products toward sustainable menstrual hygiene. *Scientific Reports, 14*(1), 22062. https://doi.org/10.1038/s41598-024-72122-7

Lathabhavan, R., & Lathabhavan, R. (2024). Understanding the behavioural drivers of mindful consumption: a study on the use of sustainable menstrual products. *Journal of Indian Business Research, 16*(2), 308-326. https://doi.org/10.1108/JIBR-01-2023-0029

Liao, X., Shen, S. V., & Shi, X. (2020). The effects of behavioral intention on the choice to purchase energy-saving appliances in China: the role of environmental attitude, concern, and perceived psychological benefits in shaping intention. *Energy Efficiency, 13*(1), 33-49. https://doi.org/10.1007/s12053-019-09828-5

Lupindo, M., Madinga, N. W., & Dlamini, S. (2024). Green beauty: examining factors shaping millennials' attitudes toward organic personal care products in South Africa. *European Journal of Management Studies, 29*(3), 271-291. https://doi.org/10.1108/EJMS-01-2024-0001

Meenakshi, N. (2020). Taboo in consumption: Social structure, gender and sustainable menstrual products. *International Journal of Consumer Studies, 44*(3), 243-257. https://doi.org/10.1111/ijcs.12562

Nekmahmud, M., Ramkissoon, H., & Fekete-Farkas, M. (2022). Green purchase and sustainable consumption: A comparative study between European and non-European tourists. *Tourism Management Perspectives, 43,* 100980. https://doi.org/10.1016/j.tmp.2022.100980

Park, E., & Kwon, S. J. (2017). What motivations drive sustainable energy-saving behavior?: An examination in South Korea. *Renewable and Sustainable Energy Reviews, 79,* 494-502. https://doi.org/10.1016/j.rser.2017.05.150

Patel, K., Dwivedy, S., Panda, N., Swain, S., Pati, S., & Palo, S. K. (2023). Is menstrual cup a sustainable and safe alternative in menstrual hygiene management? A qualitative exploratory study based on user's experience in India. *Clinical Epidemiology and Global Health, 20,* 101212. https://doi.org/10.1016/j.cegh.2022.101212

Paul, J., Modi, A., & Patel, J. (2016). Predicting green product consumption using theory of planned behavior and reasoned action. *Journal of retailing and consumer services, 29,* 123-134. https://doi.

org/10.1016/j.jretconser.2015.11.006

Pednekar, S., Some, S., Rivankar, K., & Thakore, R. (2022). Enabling factors for sustainable menstrual hygiene management practices: a rapid review. *Discover Sustainability, 3*(1), 28. https://doi.org/10.1007/s43621-022-00097-4

Peter, A., & Abhitha, K. (2021). Menstrual Cup: A replacement to sanitary pads for a plastic free period. *Materials Today: Proceedings, 47,* 5199-5202. https://doi.org/10.1016/j.matpr.2021.05.527

Pokhrel, D., Bhattarai, S., Emgård, M., Von Schickfus, M., Forsberg, B. C., & Biermann, O. (2021). Acceptability and feasibility of using vaginal menstrual cups among schoolgirls in rural Nepal: a qualitative pilot study. *Reproductive health, 18*(1), 20. https://doi.org/10.1186/s12978-020-01036-0

Poulose, J., Sharma, V., Kumar, M. D., & Bhattacharjee, S. (2024). Understanding purchase intention of menstrual products among rural Indian women: periods are normal-period!. *International Journal of Indian Culture and Business Management, 32*(1), 59-79. https://doi.org/10.1504/IJICBM.2024.138996

Prakash, G., & Pathak, P. (2017). Intention to buy eco-friendly packaged products among young consumers of India: A study on developing nation. *Journal of cleaner production, 141,* 385-393. https://doi.org/10.1016/j.jclepro.2016.09.116

Richter, N. F., Schubring, S., Hauff, S., Ringle, C. M., & Sarstedt, M. (2020). When predictors of outcomes are necessary: Guidelines for the combined use of PLS-SEM and NCA. *Industrial management & data systems, 120*(12), 2243-2267. https://doi.org/10.1108/IMDS-11-2019-0638

Sheth, J.N. (1983). An Integrative Theory of Patronage Preference and Behavior. In *W.R. Darden & R.F. Lusch* (Eds.), Patronage Behavior and Retail Management (9–28). Orlando: Elsevier.

Shimul, A. S., Cheah, I., & Khan, B. B. (2022). Investigating female shoppers' attitude and purchase intention toward green cosmetics in South Africa. *Journal of Global Marketing, 35*(1), 37-56. https://doi.org/10.1080/08911762.2021.1934770

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J. H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. *European journal of marketing, 53*(11), 2322-2347. https://doi.org/10.1108/EJM-02-2019-0189

Shukla, S., & Sanjeev, R. (2022). Examining barriers in adoption of feminine hygiene practices in developing countries: A systematic review of literature. *Journal of General Management Research, 9*(1).

Shukla, S., & Sanjeev, R. (2024). How to promote women's shift towards reusable feminine hygiene products: The application of push-pull-mooring model. *Journal of Cleaner Production, 482,* 144223. https://doi.org/10.1016/j.jclepro.2024.144223

Shukla, S., Sanjeev, R., & Sharma, P. (2024). What drives women to adopt menstrual cups? The integration of consumer values and theory of planned behaviour. *Journal of Social Marketing, 14*(3/4), 347-364. https://doi.org/10.1108/JSOCM-08-2023-0175

Sun, Y., Leng, K., & Xiong, H. (2022). Research on the influencing factors of consumers' green purchase behavior in the post-pandemic era. *Journal of Retailing and Consumer Services, 69,* 103118. https://doi.org/10.1016/j.jretconser.2022.103118

Talwar, S., Jabeen, F., Tandon, A., Sakashita, M., & Dhir, A. (2021). What drives willingness to purchase and stated buying behavior toward organic food? A Stimulus–Organism–Behavior–Consequence (SOBC) perspective. *Journal of Cleaner Production, 293,* 125882. https://doi.org/10.1016/j.jclepro.2021.125882

Teare, M. D., Dimairo, M., Shephard, N., Hayman, A., Whitehead, A., & Walters, S. J. (2014). Sample size requirements to estimate key design parameters from external pilot randomised controlled trials: a simulation study. *Trials, 15*(1), 264. https://doi.org/10.1186/1745-6215-15-264

Testa, F., Gaia, P., Iovino, R., Guia, B., Tessitore, S., & Fabio, I. (2021). Drivers to green consumption: A systematic review. *Environment, development and sustainability, 23*(4), 4826-4880. https://doi.org/10.1007/s10668-020-00844-5

Tóth, Z., & Dul, J. (2019). Necessary condition analysis in tourism research. *Annals of Tourism Research, 79,* 102821.

Tu, J. C., Lo, T. Y., & Lai, Y. T. (2021). Women's cognition and attitude with eco-friendly menstrual products by consumer lifestyle. *International Journal of Environmental Research and Public Health, 18*(11), 5534. https://doi.org/10.3390/ijerph18115534

United Nations, 2023. The sustainable development agenda. In: United Nations Sustainable Development. United Nations Sustainable Development. *Retrieved March 25,* 2023, from. https://www.un.org/sustainabledevelopment/development -agenda/.

Valentin, A. P. M., & Hechanova, M. R. M. (2023). Addressing plastic pollution through green consumption: Predicting intentions to use menstrual cups in the Philippines. *Journal of Retailing and Consumer Services, 71,* 103204. https://doi.org/10.1016/j.jretconser.2022.103204

Van Eijk, A. M., Zulaika, G., Lenchner, M., Mason, L., Sivakami, M., Nyothach, E., ... & Phillips-Howard, P. A. (2019). Menstrual cup use, leakage, acceptability, safety, and availability: a systematic review and meta-analysis. *The lancet public health, 4*(8), e376-e393. http://dx.doi.org/10.1016/ S2468-2667(19)30111-2

Xu, X., Hua, Y., Wang, S., & Xu, G. (2020). Determinants of consumer's intention to purchase authentic green furniture. Resources, Conservation and Recycling, 156, 104721.Ahuja, P., & Singh, N. (2023). Sustainable menstrual products: a classic or a fad?. *International Journal of Human Rights in Healthcare, 16*(5), 535-553. https://doi.org/10.1016/j.resconrec.2020.104721

Yamane, T., & Kaneko, S. (2021). Is the younger

generation a driving force toward achieving the sustainable development goals? Survey experiments. *Journal of cleaner production, 292,* 125932. https://doi.org/10.1016/j.jclepro.2021.125932

Yang, Y., & Kim, Y. (2023). Integrating the theory of planned behavior and bonding social capital to examine Chinese women's tampon use intentions. *Health Communication, 38*(3), 575-584. https://doi.org/10.1080/10410236.2021.1962586

Zeng, N., Liu, Y., Gong, P., Hertogh, M., & König, M. (2021). Do right PLS and do PLS right: A critical review of the application of PLS-SEM in construction management research. *Frontiers of Engineering Management, 8*(3), 356-369. https://doi.org/10.1007/s42524-021-0153-5

Zhuang, W., Luo, X., & Riaz, M. U. (2021). On the factors influencing green purchase intention: A meta-analysis approach. *Frontiers in psychology, 12,* 644020. https://doi.org/10.3389/fpsyg.2021.644020