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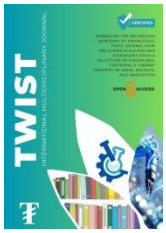

Internal Stakeholders' Awareness, Practices, and Attitudes towards Waste Electrical and Electronic Equipment Management at One State University in the Philippines

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Abstract
This study examined internal stakeholders' awareness, practices, and attitudes toward Waste Electrical and Electronic Equipment (WEEE) management at one state university in the Philippines. A descriptive cross-sectional design was employed at Laguna State Polytechnic University's Siniloan (Host) Campus. An online survey was administered via simple random sampling, yielding responses from 267 participants. The survey instruments demonstrated excellent reliability. Descriptive statistics revealed moderate levels of WEEE awareness and practices, with respondents exhibiting generally positive attitudes toward WEEE management. Multivariate analysis of covariance (MANCOVA), controlling for gender, age, and educational attainment, indicated that the respondents' role significantly influenced the combined dependent variables, with notable effects on practices and attitudes. Neither monthly income nor length of affiliation showed significant effects. Despite a significant deviation from multivariate normality, the large sample size supported the robustness of the analysis. These findings underscore the importance of role-specific factors in shaping WEEE management behaviors, suggesting a need for targeted institutional interventions.

Keywords
WEEE management, Internal stakeholders, Awareness, Practices, Attitudes

Introduction

This Waste Electrical and Electronic Equipment (WEEE) are major problem not only in the Philippines but also to other Asian country. Millions of electronic devices have been manufactured every year, but after a few years they become obsolete because innovative technology designs are coming out in the market (Herat & Agamuthu, 2012). Numerous investigations have indicated that there is a moderate level of understanding regarding electronic waste; however, their comprehension and implementation of effective e-waste management practices remain lacking (Mahat et al., 2019; Kalana, 2010). The predominant challenge associated with electronic waste pertains to the inadequate attitudes exhibited towards the management and recycling of such materials. As reported by Alias et al. (2015), a considerable proportion of initiatives aimed at enhancing awareness of e-waste management encountered receptivity, attributable to the insufficient awareness concerning e-waste management challenges and their implications.

In the Republic Act No. 6969 (R.A. No. 6969) toxic substance and hazardous nuclear waste control act of 1990 the WEEE is included in the hazardous waste. The R.A. No. 6969 scope includes the keeping or storage and disposal and should be effectively managed. According to Azelee and Selvasemba (2023) focusing on environmental and toxicological impact discarded electronic devices. Additionally improper disposal of electronic and electrical equipment in educational institutions can lead to environmental pollution. According to World Health Organization (2024), Ghulam and

Abushammala (2023), improper electronic devices asset management can affect human health and environment and there should be a plan about sustainable WEEE management practices that can be adopted by educational institution to mitigate this risk. It supported with the study of Zhang and Xu (2019) that emphasize the need for regulatory framework within educational setting to ensure the electronic and electrical equipment is manage and suitability. Additionally, according to Agamuthu et al. (2015), that higher education institutions significantly contribute to WEEE, with universities generating substantial amount of ICT waste, such as computers and printers.

Higher Education institutions like Laguna State Polytechnic University use different electrical and electronic devices to make their work easier and more efficient work output but when these devices fail to work or obsolete, they are considered WEEE. Laguna State Polytechnic University (LSPU) purchase electronic equipment like computers units, laptops, UPS, Power Supply, air-conditioning, industrial fan, electric fan, printers, monitors, Television, lights, laboratory equipment and other devices that used electricity that are needed to the workplaces.

Fast growing integration of technology in education affects various aspects of teaching, learning and managing school. Managing electronic devices has emerged as a critical issue in educational management. Due to rapid technological advancement, electronic devices quickly become outdated necessitating their replacement. That will result in not being effectively managed and lots of e-waste piles inside the university. Forti et al., (2020) stated this rapid cycle technology use and disposal has led to the accumulation of electronic waste (WEEE), which poses both environmental and health risk. WEEE contains hazardous materials that, if not effectively managed, can lead to environment degradation and public health risks.

With these premises, the present study aimed to evaluate the levels of awareness, practices, and attitudes regarding Waste Electrical and Electronic Equipment (WEEE) management at Laguna State Polytechnic University (LSPU). Specifically, the study examined whether significant differences and correlations exist in knowledge, awareness, and practices related to WEEE management when respondents are categorized according to their demographic profiles.

MATERIALS AND METHODS

A descriptive cross-sectional research design was employed to examine the internal stakeholders' levels of awareness, practices, and attitudes toward Waste Electrical and Electronic Equipment (WEEE) management at Laguna State Polytechnic University (LSPU). The study was conducted at LSPU's Siniloan (Host) Campus, one of four campuses in the province of Laguna (the others being the Sta. Cruz Campus, San Pablo City Campus, and Los Baños Campus). The Siniloan Campus was selected due to its diverse academic programs and the daily presence of various stakeholders—including administrators, faculty, and students.

Prior to data collection, the researchers obtained approval from the Campus Director. An online survey was then administered using a simple random sampling technique. Deans from eight different colleges assisted in disseminating the Google survey link to faculty and students, and the link was also shared via a Facebook group chat to reach administrators. Over the course of approximately one month, responses were collected from a total of 267 participants (11 administrators, 35 faculty members, and 221 students). The responses were initially collected via Google Forms and later exported to Microsoft Excel for analysis.

Descriptive statistics were used to summarize the study variables, while the Pearson *r* correlation coefficient assessed relationships among them. Assumption checks were conducted prior to performing multivariate analysis to test for significant differences in awareness, practices, and attitudes toward WEEE management. Throughout the study, all ethical considerations were strictly observed.

RESULTS AND DISCUSSION

Table I Cronbach Alpha Values of the Construct Variables

Construct	Cronbach's Alpha values	Interpretation
Awareness	0.959	excellent
Practices	0.985	Excellent
Attitude	0.969	Excellent

Table I presents the Cronbach's alpha coefficients for the scales measuring respondents' awareness, practices, and attitudes toward Waste Electrical and Electronic Equipment (weee) management at laguna state polytechnic university (lspu). The reliability estimates indicate excellent internal consistency for all constructs: awareness (α = 0.959), practices (α = 0.985), and attitude (α = 0.969). A study at Valenzuela City Polytechnic College assessed Electronics Technology students' knowledge, practices, and attitudes toward e-waste management, reporting strong internal consistency in its measures, with Cronbach's alpha values of 0.784 for knowledge, 0.836 for practices, and 0.893 for attitudes (Goyal, J. K. C., 2023). Similarly, research conducted at a Zimbabwean university examined students' awareness and attitudinal disposition toward e-waste management using a structured questionnaire, yielding identical Cronbach's alpha values, further confirming the reliability of the constructs measured.

The descriptive statistics presented in Table 1 provide insights into the demographic characteristics and responses of the 267 study respondents regarding Waste Electrical and Electronic Equipment (WEEE) management at LSPU. In terms of gender distribution, the mean score of 1.51 (with a median of 2) suggests a fairly balanced representation of male

and female respondents. The age distribution (M = 1.33, SD = 0.834) indicates that most respondents belong to a younger age group.

Table 2 Descriptive Statistics of the Variables of the Study

	N	Missing	Mean	Median	SD	Minimum	Maximum
Gender	267	0	1.51	2	0.501	1	2
Age	267	0	1.33	1	0.834	1	5
Role LSPU	267	0	2.79	3	0.501	1	3
HEA	267	0	1.90	2	0.314	1	3
Monthly Income	267	0	1.73	1	0.983	1	6
Length Affiliation LSPU	267	0	1.20	1	0.695	1	5
Awareness	267	0	3.43	3.50	0.887	1.00	5.00
Practices	267	0	3.32	3.41	1.000	1.00	5.00
Attitude	267	0	4.06	4.00	0.745	1.70	5.00

The role of respondents at LSPU (M = 2.79, SD = 0.501) suggests that the majority of the participants are students, which is expected in an academic institution. Regarding educational attainment, the mean score of 2.79 (SD = 0.314) indicates that most respondents have at least a college-level education. The length of affiliation with LSPU (M = 1.20, SD = 0.695) suggests that many respondents have been with the university for a relatively short period, likely consisting of newly enrolled students. In terms of WEEE awareness, the results indicate a moderate level of awareness (M = 3.43, SD = 0.887), suggesting that while respondents have some knowledge of WEEE, there may be gaps that require further education or training. The practice of WEEE management (M = 3.32, SD = 1.000) shows that respondents are somewhat engaged in WEEE-related activities, but the high standard deviation suggests variability in practices across the sample. Finally, attitudes toward WEEE disposal (M = 4.06, SD = 0.745) indicate that respondents generally agree on the importance of proper WEEE management, reflecting positive perceptions and a willingness to engage in responsible disposal practices. In general, the findings suggest that while awareness and attitudes toward WEEE disposal are relatively high, actual practices are slightly lower, indicating a potential gap between knowledge and implementation. These results highlight the need for enhanced institutional initiatives, awareness campaigns, and policy enforcement to ensure consistent and effective WEEE management within LSPU. A study at Mindanao State University-Iligan Institute of Technology (MSU-IIT) found that students across different colleges had a high level of knowledge about e-waste components and their harmful effects on health and the environment, with mean scores ranging from 3.58 to 4.16. Additionally, students demonstrated a positive attitude toward e-waste recycling initiatives, with mean scores between 3.88 and 4.40.

Table 2 Correlation Matrix

	1	2	3	4	5	6	7	8	9
1. Gender	—								
2. Age	-0.220 ***	—							
3. Role LSPU	0.237 ***	-0.685 ***	—						
4. HEA	0.183 **	-0.518 ***	0.602 ***	—					
5. Monthly Income	-0.085	0.454 ***	-0.462 ***	-0.479 ***	—				
6. Length Affiliation LSPU	-0.138 *	0.775 ***	-0.590 ***	-0.527 ***	0.443 ***	—			
7. Awareness	-0.002	-0.033	0.017	-0.013	-0.060	-0.059	—		
8. Practices	0.016	-0.160 **	0.102	0.111	-0.207 ***	-0.151 *	0.771 ***	—	
9. Attitude	-0.146 *	0.136 *	-0.193 **	-0.139 *	0.148 *	0.039	0.419 ***	0.290 ***	—

Note. * p < .05, ** p < .01, *** p < .001

Table 2 presents the test of significant relationships between respondents' awareness, practices, and attitudes toward Waste Electrical and Electronic Equipment (WEEE) management at Laguna State Polytechnic University (LSPU), grouped according to their demographic profile.

Gender was found to have no significant relationship with awareness (r = −0.002) and practices (r = 0.016) related to WEEE management, suggesting that knowledge and engagement in WEEE disposal are not inherently influenced by gender. However, a negative significant correlation between gender and attitude (r = −0.146) implies that males and females may differ in their perceptions of WEEE disposal, with one gender potentially exhibiting a more favorable outlook. This finding underscores the importance of understanding gender-based differences in environmental attitudes to develop targeted awareness campaigns.

Age demonstrated mixed effects on WEEE management. The negative correlation between age and practices (r = −0.160) suggests that older respondents are less likely to actively engage in proper WEEE disposal. This may be attributed to factors such as reduced exposure to digital waste management strategies or resistance to new environmental practices. Conversely, the positive correlation between age and attitude (r = 0.136) indicates that older individuals tend to hold more favorable views toward WEEE management, which may be linked to their awareness of environmental consequences. Despite these insights, no significant relationship was found between age and awareness (r = −0.002), suggesting that knowledge about WEEE is relatively uniform across different age groups.

The respondents' role at LSPU was negatively correlated with attitudes toward WEEE management (r = −0.193), indicating that individuals in different institutional roles perceive WEEE disposal differently. However, the lack of significant correlation between role and both awareness (r = 0.017) and practices (r = 0.102) suggests that knowledge and actual engagement in WEEE management remain consistent across various professional positions within the university. This finding highlights the need for institution-wide policies that encourage uniform engagement in WEEE disposal, regardless of one's role.

Educational attainment also played a role in shaping WEEE-related attitudes. A negative correlation with attitude (r = −0.139) suggests that respondents with higher educational levels were less likely to hold positive views on WEEE management. This may reflect a disconnect between formal education and environmental responsibility or a perception that WEEE management is not a priority. However, no significant correlation was found between educational attainment and awareness (r = −0.013) or practices (r = 0.111), indicating that higher education does not necessarily translate to better WEEE-related knowledge or behavior. These findings suggest a need to integrate environmental awareness programs into higher education curricula to reinforce the importance of sustainable e-waste disposal.

Monthly income was found to influence attitudes and practices in opposing ways. The positive correlation between income and attitude (r = 0.148) suggests that individuals with higher earnings tend to have more favorable views on WEEE management, possibly due to increased access to resources or environmental awareness campaigns. However, the negative correlation between income and practices (r = −0.207) implies that higher-income respondents engage less in actual WEEE disposal activities. This discrepancy may stem from convenience factors, where higher-income individuals may rely on others to handle e-waste, or a lack of motivation due to financial stability. The absence of a significant relationship between income and awareness (r = −0.060) further indicates that financial standing does not necessarily influence knowledge about WEEE issues.

The length of affiliation with LSPU was negatively correlated with WEEE management practices (r = −0.151), suggesting that individuals who have been with the institution longer are less likely to engage in proper e-waste disposal. This may be due to institutional culture, where long-term members may have become accustomed to existing practices, regardless of sustainability considerations. However, the lack of significant correlation with awareness (r = −0.059) and attitude (r = 0.039) suggests that tenure does not necessarily impact knowledge or perceptions of WEEE management. These findings highlight the need for ongoing institutional interventions to ensure long-term members remain engaged in sustainable practices.

One of the most notable findings of this study is the negative correlation between awareness and practices (r = −0.151), which suggests that despite having knowledge of WEEE management, respondents do not necessarily translate this awareness into action. This finding highlights a critical gap between knowledge and behavior, which may be attributed to factors such as lack of institutional reinforcement, limited access to proper disposal facilities, or insufficient motivation to engage in WEEE-related activities. Additionally, the absence of a significant correlation between awareness and attitude (r = 0.039) indicates that knowledge alone does not directly influence how respondents perceive WEEE management. These results suggest that external factors, such as environmental values, personal convenience, or university policies, may play a more significant role in shaping attitudes and behaviors. Ang et al. (2023) found that individuals with strong environmental values are more likely to engage in proper e-waste disposal, emphasizing the need to foster environmental concerns to promote sustainable behaviors. Additionally, another study examined various factors influencing e-waste recycling, including environmental knowledge, public awareness, convenience, infrastructure, willingness to pay, and data security. The findings suggest that improving environmental knowledge and public awareness can significantly enhance recycling intentions, reinforcing the importance of environmental values in encouraging responsible e-waste management.

Table 3 presents the results from the multivariate analysis of covariance (MANCOVA) was conducted to assess whether there were significant differences in awareness, practices, and attitudes toward Waste Electrical and Electronic Equipment (WEEE) management based on respondents' role at Laguna State Polytechnic University (LSPU), monthly income, and length of affiliation at LSPU, while controlling for gender, age, and highest educational attainment (HEA).

Table 3 Multivariate Test Results

Effect	Tests	value	F	df1	df2	p
Role LSPU	Pillai's Trace	0.1278	5.3469	6	470	< .001
	Wilks' Lambda	0.874	5.4179	6	468	< .001
	Hotelling's Trace	0.1413	5.4882	6	466	< .001
	Roy's Largest Root	0.1214	9.5103	3	235	< .001
Monthly Income	Pillai's Trace	0.0737	1.1883	15	708	0.275
	Wilks' Lambda	0.928	1.1873	15	646	0.276
	Hotelling's Trace	0.0764	1.1856	15	698	0.277
	Roy's Largest Root	0.0461	2.1755	5	236	0.058
Length Affiliation LSPU	Pillai's Trace	0.0630	1.2656	12	708	0.234
	Wilks' Lambda	0.938	1.2668	12	619	0.234
	Hotelling's Trace	0.0653	1.2666	12	698	0.234
	Roy's Largest Root	0.0451	2.6601	4	236	0.033

The multivariate test results indicate that respondents' role at LSPU had a significant effect on the combined dependent variables (awareness, practices, and attitude) across all four multivariate statistics: Pillai's Trace, $V = 0.1278$, $F(6, 470) = 5.35$, $p < .001$; Wilks' Lambda, $\Lambda = 0.874$, $F(6, 468) = 5.42$, $p < .001$; Hotelling's Trace, $T = 0.1413$, $F(6, 466) = 5.49$, $p < .001$; and Roy's Largest Root, $R = 0.1214$, $F(3, 235) = 9.51$, $p < .001$. These results suggest that the role of respondents at LSPU significantly influences their awareness, practices, and attitudes toward WEEE management. Table III presents the results from the multivariate analysis of covariance (MANCOVA) was conducted to assess whether there were significant differences in awareness, practices, and attitudes toward Waste Electrical and Electronic Equipment (WEEE) management based on respondents' role at Laguna State Polytechnic University (LSPU), monthly income, and length of affiliation at LSPY, while controlling for gender, age, and highest educational attainment (HEA).

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However, the monthly income of respondents did not show a statistically significant multivariate effect on awareness, practices, and attitudes, $V = 0.0737$, $F(15, 708) = 1.19$, $p = .275$, indicating that income level was not a major determinant in these variables. Similarly, length of affiliation at LSPU did not yield a significant multivariate effect, $V = 0.0630$, $F(12, 708) = 1.27$, $p = .234$. This suggests that financial standing does not necessarily influence an individual's engagement in WEEE management. A possible explanation is that WEEE disposal behaviors are more influenced by institutional norms and accessibility to proper disposal facilities rather than personal financial resources. Likewise, it suggests that long-term exposure to the university's environment alone is insufficient to foster sustainable WEEE management behaviors. Institutional efforts must therefore focus on continuous engagement and reinforcement of proper e-waste disposal practices, regardless of tenure.

Regarding interaction effects, the interaction of role at LSPU and monthly income was not significant, $V = 0.0517$, $F(18, 708) = 0.69$, $p = .824$, nor was the interaction between role at LSPU and length of affiliation, $V = 0.0600$, $F(15, 708) = 0.96$, $p = .494$. Additionally, the three-way interaction between role, monthly income, and length of affiliation was also not significant, $V = 0.0128$, $F(3, 234) = 1.01$, $p = .388$. These findings suggest that WEEE awareness, practices, and attitudes are shaped more by individual role responsibilities rather than the combined effects of income and institutional tenure. The absence of significant interaction effects implies that institutional policies and initiatives should focus primarily on role-specific interventions rather than tailoring programs based on financial or tenure-related factors.

The covariates, gender ($V = 0.0127$, $p = .392$), age ($V = 0.0159$, $p = .288$), and highest educational attainment ($V = 0.00099$, $p = .972$), did not exhibit significant multivariate effects, suggesting that these demographic factors did not play a major role in influencing awareness, practices, and attitudes. These findings reinforce the idea that institutional role plays a more dominant role in shaping WEEE management behaviors compared to personal demographic attributes. This contradicts common assumptions that higher education or age would necessarily lead to greater environmental awareness or responsibility. It also highlights the importance of institutional structures, policies, and role-specific duties over individual characteristics in promoting effective WEEE management.

In general, the significant multivariate effects associated with respondents' role at LSPU underscore the importance of institutional position in shaping WEEE management behaviors and perceptions. The non-significant findings for monthly income, length of affiliation, and the covariates suggest that these factors are less critical in explaining variations in the dependent variables. Future interventions and policies aimed at enhancing WEEE

management practices might benefit from focusing on role-specific factors rather than general demographic or socioeconomic characteristics. This finding suggests that long-term exposure to the university's environment alone is insufficient to foster sustainable WEEE management behaviors. Institutional efforts must therefore focus on continuous engagement and reinforcement of proper e-waste disposal practices, regardless of tenure.

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Table 4 Univariate Tests

	Dependent Variable	Sum of Squares	df	Mean Square	F	p
Role LSPU	Awareness	0.26211	2	0.13105	0.16037	0.852
	Practices	9.61222	2	4.80611	4.86756	0.008
	Attitude	5.63330	2	2.81665	5.22293	0.006
Monthly Income	Awareness	3.79553	5	0.75911	0.92893	0.463
	Practices	6.15727	5	1.23145	1.24720	0.288
	Attitude	1.20229	5	0.24046	0.44588	0.816
Length Affiliation LSPU	Awareness	2.27500	4	0.56875	0.69599	0.595
	Practices	4.70241	4	1.17560	1.19063	0.316
	Attitude	2.60915	4	0.65229	1.20954	0.307

Table IV presents the Univariate tests conducted to explore the effects of independent variables on each dependent variable. While the effect of role at LSPU was not significant for awareness, $F(2, 236) = 0.16$, p = .852, it was significant for practices, $F(2, 236) = 4.87$, $p = .008$, and for attitude, $F(2, 236) = 5.22$, p = .006. This suggests that institutional position plays a role in shaping how individuals engage with WEEE management behaviors. This aligns with prior research indicating that individuals in different roles have varying levels of responsibility, exposure, and engagement with institutional policies, which may affect their willingness to follow proper e-waste disposal practices and their attitudes toward sustainability initiatives.

One potential explanation for this finding is that employees or faculty members at LSPU may have greater exposure to institutional policies, training, or directives regarding WEEE management, making them more likely to develop positive practices and attitudes. Conversely, students, who may have fewer institutional responsibilities, could be less engaged in WEEE disposal practices, contributing to the observed differences. This result highlights the need for role-specific interventions to strengthen WEEE management practices and attitudes across all university stakeholders. For

instance, policies could focus on integrating sustainability training for employees and faculty members, while students might benefit from awareness campaigns or curriculum-based learning on e-waste disposal.

Other independent variables, such as monthly income and length of affiliation at LSPU, did not show significant univariate effects on awareness, practices, or attitudes. Similarly, interaction effects and covariates did not show significant influence on the dependent variables at the univariate level. This suggests that, regardless of institutional position, respondents had similar levels of awareness about WEEE management. A possible explanation is that information regarding WEEE disposal is universally available within the institution, through general announcements, environmental campaigns, or other university-wide efforts that ensure all members of the academic community have similar exposure to information about e-waste.

However, despite this level of awareness, differences in practices and attitudes suggest a gap between knowledge and action. This finding implies that simply increasing awareness is insufficient to drive proper WEEE management behaviors. Future initiatives should focus not just on disseminating information but also on actively encouraging behavioral change and fostering a more positive attitude toward WEEE management.

For the assumption checks, the Box's M test for homogeneity of covariance matrices could not be calculated due to insufficient observations in some subgroups. However, the Shapiro-Wilk test for multivariate normality was significant, $W = 0.906$, $p < .001$, indicating a deviation from normality. Despite this violation, MANCOVA is generally robust to minor departures from normality, particularly with large sample sizes (Tabachnick & Fidell, 2021). Given that the sample size in this study was 267 respondents, the use of MANCOVA remains appropriate. Arain et al. (2020) evaluated e-waste recycling behaviors among faculty, graduate students, undergraduate students, and staff at a large Midwestern university in the United States. The univariate analysis revealed significant differences in recycling practices based on institutional roles. Faculty and staff demonstrated higher engagement in proper e-waste disposal compared to students, suggesting that increased exposure to institutional policies and responsibilities influences positive e-waste management behaviors. Similarly, Jabim and Musoke (2024) assessed students' knowledge, attitudes, and practices regarding e-waste management at Makerere University in Uganda. Their study found that students' academic disciplines significantly influenced their engagement in e-waste management practices, with environmental science students exhibiting higher levels of awareness and proactive attitudes toward e-waste disposal compared to their peers in other disciplines.

CONCLUSION

In conclusion, the study demonstrates that internal stakeholders' roles at Laguna State Polytechnic University significantly influence their practices and attitudes toward WEEE management, although awareness levels remain uniformly moderate across groups. These results indicate that while general awareness initiatives may have reached a broad audience, role-specific factors such as institutional responsibilities and access to resources are key determinants of effective WEEE management. In contrast, variables such as monthly income and length of affiliation did not significantly affect stakeholders' behaviors. The overall findings highlight a potential gap between awareness and the actual implementation of WEEE management practices, suggesting that effective management is contingent upon tailored strategies that address the unique needs of different stakeholder groups.

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DECLARATION OF CONFLICT

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

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