Factors Affecting for E-Waste Recycling in Sri Lanka

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Abstract- Owing to the recent technological advancements and growing tendency to embrace technology has tremendously increased the use of Electrical and Electronic Equipment (EEE) both in developed and developing countries. Consequently, this led to accumulation of large quantities of e-waste around the world. Importantly, management and proper disposal of household e-waste in almost every country including Sri Lanka has become a prevailing challenge. Evidently, Sri Lanka has given a minimum priority for systematic e-waste management compared to the developed countries. The main aim of this research is to examine the factors influencing the e-waste recycling of households in Sri Lanka. Hence, this research was conducted as a quantitative study involving cross-sectional survey, gathering valid responses from 245 households. Multiple Regression Analysis was employed to analyze the data and tested the constructed hypotheses. The findings exhibited that attitude and perceived convenience are the factors that influence willingness of e-waste recycling of Sri Lankan households. A succinct overview of Sri Lanka's household perception of current e-waste recycling is emphasized in this research. Ultimately, findings would support the relevant waste management authorities in Sri Lanka to plan and execute effective strategies to manage household e-waste.

Index Terms- Electrical and Electronic Equipment, E-Waste, Recycling, Willingness,

I. INTRODUCTION

Presently, exponential growth in manufacturing and subsequent use of sophisticated EEE is commonly witnessed all around the world. In fact, there is an incessant production of EEE with rapid cutting-edge technical enhancements striving to feed the respective growing consumer demand. Moreover, duration of expected use of some EEE such as communication devices has drastically reduced with frequent arrival of upgraded versions embedded with enhanced user friendly smart features and high-performance capabilities. Consequently, rising demand with increasing tendency of replacing/upgrading EEE and acceleration of production with minimum attention to Waste Electrical and Electronic (WEEE) recycling has created a major threat for both the humanity and natural environment (Nixon, Saphores, Ogunseitan, & Shapiro, 2009). Regretfully, it is evident that most of the consumers tend to discard WEEE without practicing a proper environmental friendly disposal mechanism (Borthakur, Anwesha, Sinha, & Kunal, 2013). Mainly, these disposed WEEE contain numerous toxic chemicals and other harmful substances. Thus, WEEE cannot be treated as normal junk. Many countries, including both the developed and developing countries have taken several counter measures to manage WEEE disposal with the aim of minimizing the harm. Major protective step acknowledged is the proper recycling of WEEE (Ray, 2008). Therefore, managing WEEE by proper recycling would minimize the negative results affected for human livelihood and natural environmental. Presently, Sri Lanka is similarly encountering the problem of managing WEEE. However, insufficient countermeasures have been taken to address the issue of managing e-waste (Mallawarachchi & Karunasena, 2012). The researchers argue that there exists a gap in examining the extent of Sri Lankan consumer readiness on e-waste management and recycling. Thus, researchers seek to address aforementioned issue via this empirical research.

II. LITERATURE REVIEW

1.1. E-waste

Increasing use and frequent replacement of EEE gave a rise to the e-waste as an emerging phenomenon that happens be challenging the existence of humanity and nature. Although the concept of WEEE has been predominantly received interest among many scholars, research studies are still progressing aimed at exploring appropriate strategies to minimize the harmfulness. Many reputed organizations and scholars embarked to conceptually define e-waste or WEEE as an initially approach to investigate this phenomenon. E-waste is all obsolete or outdated electronic and electrical devices commonly used in offices, homes and by people on the go (Electronic Recyclers of America, 2006). Similarly, e-waste is referred as an end-of-life equipment, whose working depends on electric current or electromagnetic field (United Nations Environmental Programme, 2007). Organization of Economic Cooperation and Development (2001) defined e-waste as "any appliance using electric power supply that has reached its end-of-life". The Directive 2012/19/EC defined e-waste as the electrical or electronic equipment which is waste including all components, subassemblies and consumables which are part of the product at the time of discarding. Above mentioned directive lists ten categories of e-waste namely: large household appliances; small household appliances; IT and telecommunication equipment; consumer equipment; lighting equipment; electrical and electronic tools (with the exception of large scale stationary industrial tools); toys, leisure and sports equipment; medical devices (with the exception of all implanted and infected products); monitoring and control instruments; and automatic dispensers.

It is evident that usage of EEE including computers, mobile phones and entertainment electronics has proliferated and disposing them is growing rapidly throughout the world. The amount of e-waste in the newly industrialized and developing countries is relatively growing up due to the increasing tendency to import e-waste from developed countries. Approximately, 50–80% of the WEEE accumulated in developed markets is being shipped to developing countries for reuse and recycling (Widmer, Oswald-Krapf, Sinha-Khetriwal, & Schen, 2005). Sri Lanka as a developing country imports large amounts of EEE a year. Following table shows the annual import (legally) statistics of major types of EEE in Sri Lanka, their average useful life times and the forecasted growth rate in next couple of years.

Table: Statistics of major types of EEE in Sri Lanka

Item	PC	Printers	TV	Mobile Phones	AC	Refrige.	Washing Machines	Batteries
Annual Imports	300,000	130,000	400,000	1,200,000	40,000	250,000	70,000	6,000,000
Average Life (yrs)	6	6	12	3	15	25	20	0.2
Forecasted Growth	12%	7%	7%	40%	5%	5%	8%	1%

Source: Sri Lanka Customs (2010)

However, a little concern is paid on managing the obsolete or damaged equipment which are no longer in usable state.

Recycling of WEEE is an important subject not only from the point of waste treatment but also from the recovery aspect of valuable materials. (Cui & Eric, 2003).

E-waste is chemically and physically distinct from other forms of municipal or industrial waste; it contains both valuable and hazardous materials that require special handling and recycling methods to avoid environmental contamination and detrimental effects on human health. Indeed, e-waste contains many toxic materials such as lead (Pb), cadmium, mercury, barium, beryllium, hexavalent chromium, and brominated flame-retardants. Recycling can recover reusable components and base materials, especially Cu and precious metals. However, due to lack of facilities, high labour costs, and tough environmental regulations, rich countries tend **not** to recycle E-waste. Instead, it is either landfilled, or exported from rich countries to poor countries, where it may be recycled using primitive techniques and little regard for worker safety of environmental protection.

E-waste not only includes house-hold and industrial electrical appliances but also components such as, batteries, capacitors, castings, cathode-ray tubes, glass, etc are also included in them. (Environment, 1989).This may release several pollutants in the environment, on exposure to which, might result in several negative effects on various biotic and abiotic components in vicinity of such informal recycling plants (Wong , Duzgoren-Aydin, Aydin, & Wong , 2007) (Fu , Zhou , & Liu , 2008) Anecdotal reports suggest that a large percentage of discarded e-waste is exported to Asia, where processing is very cheap; unfortunately, e-waste is often handled improperly there, which results in severe human exposure and environmental pollution (Coalition, 2002). When it is not exported, discarded e-waste is often landfilled. It has become the largest contributor of Pb to the solid waste stream in the United States since the creation of battery recycling programs (EPA,2000).

Most common ways of exposure to hazardous components of e-waste is by ingestion, skin contact and inhalation, through mediums like contaminated soil, water, food and air (Robinson, 2009). Pregnant women, workers in the informal e-waste recycling plants, children, and other vulnerable populations come across comparatively more risks of exposure ((ATSDR), 2012). Children are at maximum risk because of additional mediums of exposure (eg, maternal feeding), excessive dermal contact behaviors (eg, hand-to-mouth activities in early years and care less behaviors while growing ages), and their changing body requirements (eg, more intake of water and food, and low rates of toxin elimination) (Pronczuk de Garbino, 2004). The effect can also transfer from workers in informal recycling plants to other family members through dermal contact, clothes, etc.

III. THEORETICAL BACKGROUND

An in-depth analysis of literature shows that at the household, municipal, and student levels, the factors that influence on recycling behavior was explained using the TRA-TPB theoretical framework. (Largo-Wight, Bian, & Lange, 2012) (Oom Do Valle, Rebelo, Reis , & Menezes, 2005)
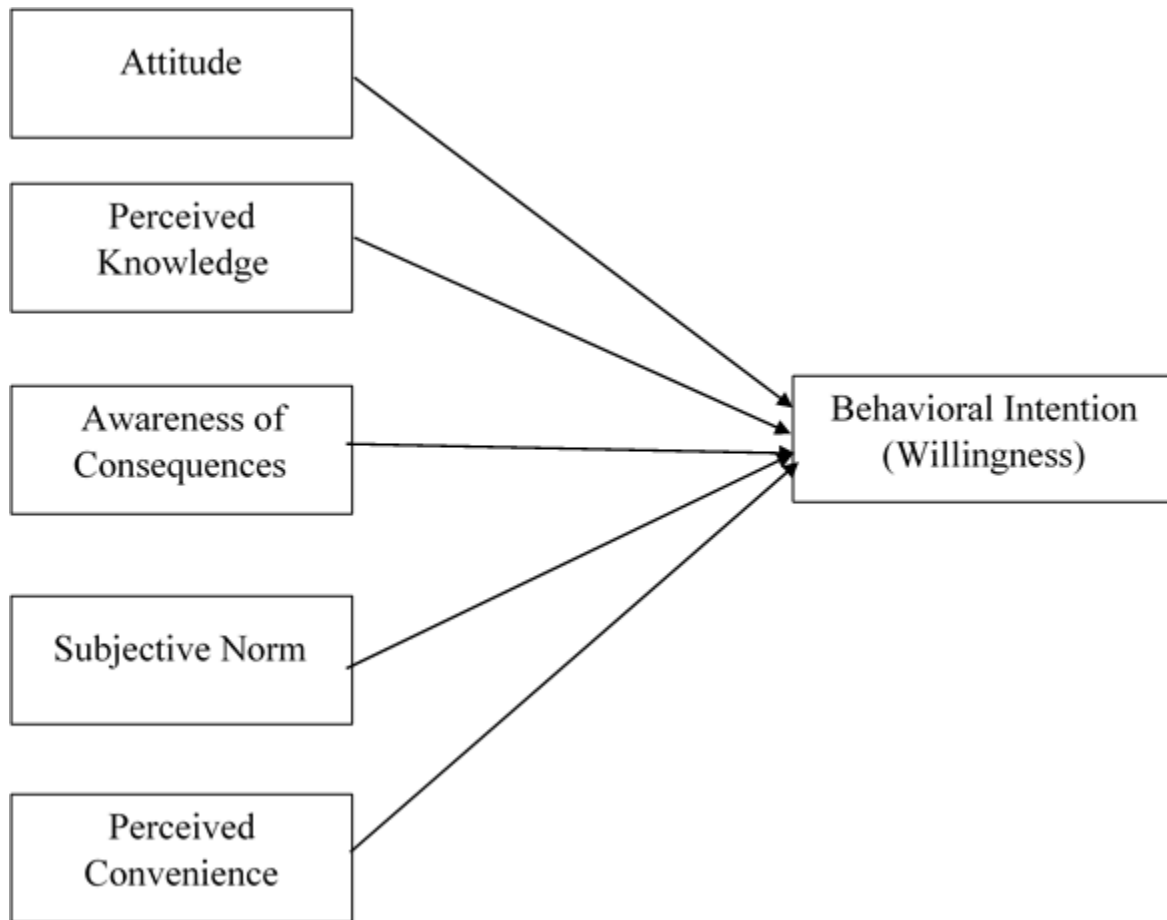
Theory of Planned Behavior (TPB)

The Theory of Reasoned Action (TRA; (Ajzen & Fishbein, Understanding Attitudes and Predicting Social Behaviour, 1980)) suggested that an individual's intention to perform certain behaviors is the immediate determinant of that behavior and it consists of two parts. The first part states that an individual act in a rational manner and she or he uses the available information before doing so (attitude). The second part states that the attitude toward the specific behavior and subjective norms determines the individual's intentions (Subjective norm). But the performance of certain behaviors is usually deterred by the lack of adequate opportunities, knowledge, time etc (Liska, 1984). Therefore, in order to overcome those circumstances Theory of Planned Behaviour (TPB) (Ajzen, "The theory of planned behaviour", 1991) extended the TRA by adding other variables which explains

an individual's behavior. These variables are called Perceived Behavioral Control (PBC). It also consists of two parts and one is external conditions and the other one is individual's perceived ability. This theory has been widely used in attitude- behavior studies.

IV. RESEARCH MODEL AND HYPOTHESIS

Mainly this study contributes to the literature by concentrating on eCycling concept from consumers' perspective. And in order to build up the conceptual framework both TRA and as well as TPB have been used along with the aforementioned literature.

- *eCycling Behavioral intention*

eCycling intention can be defined as the individual's willingness to recycle e-waste in the future (Ajzen & Fishbein, Understanding Attitudes and Predicting Social Behaviour, 1980). Past literature it is mentioned that person's behavioral intention is substantially related to actual behavior . Therefore it used as a proxy for behavior.

- *Attitude toward eCycling*

The attitude toward behavior is defined by (Ajzen & Fishbein, Understanding Attitudes and Predicting Social Behaviour, 1980)as "an individual's beliefs toward behavior and evaluation that captures an individual's perceptions about that behavior". In this study as the attitude toward eCycling the individual's favorable or unfavorable assessment of performing eCycling has been taken. But in the past literature some researchers identified that this fact as a very important predictor of recycling behavior (Calvin , Ronnie, & Geoffrey Qiping, 2012); (Chu & Chiu, 2003) while some as unimportant factor (Davies,

Foxall, & Pallister, 2002). By considering all, following hypothesis is proposed,

H1. Attitude toward eCycling correlates to eCycling intention.

- *Perceived knowledge*

In order to perform the intention or willingness associated with recycling one must have an adequate knowledge to perform these actions. Hence, fortitude of one's knowledge is essential in order to assess his/her preparation in adopting the environmentally responsible behaviour. In many studies, the importance of perceived knowledge has been confirmed (Aung & Arias,, 2006). For instance, some studies find that knowledge is a significant predictor and correlates positively with environmental behaviour (Chu & Chiu, 2003). However, contrary to common expectation, several other research findings show that higher levels of knowledge do not necessarily translate into substantially higher levels of behavioural activities (Marandu, Moeti , & Joseph,

2010). Therefore, the following hypothesis is proposed regarding Perceived knowledge:

H2. Perceived knowledge correlates to eCycling intention.

- *Awareness of consequences*

In many observed studies Anxieties for the environment is perceived to be one of the important encouragers of recycling behavior. In this study, awareness of consequences is defined as the individual's awareness of environmental consequences when the individual behaves in a certain way. There are contradictions in recycling literature about how awareness of consequences influences behavioral intentions.

Although, numerous studies have confirmed that awareness of consequences and the environmental concerns associated with recycling positively predict recycling intentions (Calvin , Ronnie, & Geoffrey Qiping, 2012) (Tonglet, Phillips, & Read, "Using the theory of planned behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK", 2004)found a negative relationship between awareness and intentions. However, the empirical studies focus on eCycling find that awareness of environmental consequences is a positive significant predictor of eCycling behavior such as paying for green electronics. Hence, the following hypothesis is proposed regarding the awareness of consequences:

H3. Awareness of consequences correlates to eCycling intention.

- *Subjective norms*

A subjective norm can be defined as social pressure and it is a function of the perceived expectations by other individuals or groups who are important or close to a person, and that person's motivation to comply with these expectations (Ajzen & Fishbein, Understanding Attitudes and Predicting Social Behaviour, 1980). That means the pressure from peers, family and neighbors has a positive effect on behavior of recycling. Past literature also stated that this is one of the vital factor in motivating recycling behavior. (Oskamp, Harrington , Edwards, & Sherw, 1991) (Sidique, Lupi, & Joshi, 2010)

H4. Subjective norms correlates to eCycling behavior.

- *Perceived convenience*

The number of expected recycling site visits increased when recycling was considered a convenient activity (Sidique, Lupi, & Joshi, 2010). Time, space and the perceived ease of an individual in managing waste can be considered as the convenience (Tonglet, Phillips, & Bates , "Determining the drivers for householder pro-environmental behaviour: waste minimisation compared to recycling", (2004b)).

H5. Perceived convenience correlates to eCycling intention.

V. METHODOLOGY

4.1 population

In order to conduct the research university students have been taken as the subject population because they potentially respond differently from non-student consumers and they are an important group of consumers (Peterson, 2001)

According to (Carlson, 1971)"students are 'unfinished' personalities". Therefore, they differ from non-students based on number of specific psychological dimensions and as well as behavioral dimensions. Another fact is that today's university students are rapidly changing and they are very nontraditional. And also "college students are likely to have less-crystallized attitudes, less-formulated senses of self, stronger cognitive skills, stronger tendencies to comply with authority, and more unstable peer group relationships" (Sears, 1986)and they are more homogeneous than non-students (Calder, et al., 1981). Therefore, this research investigates the determinants of eCycling behavior using university students as subjects. Regardless of the limitation, this study executes students as an important group to sample because they are the representatives of future generation that is likely to use technology and better understanding them allows better preparation for how to develop attitudes about eCycling.
Finally, university students can be taken as a representation of all consumers because past literature also suggests that university students' behavior has an impact on the general public and broader humanity (Calvin , Ronnie, & Geoffrey Qiping, 2012) (Kelly, Mason, Leiss , & Ganesh, 2006).

Considering all, people need a better understanding of consumer behavior with e-waste to reduce e-waste and its potential threat to humanity and the environment. This paper examines the determinants of eCycling intention using university students as the subject population.

4.2 Questionnaire Design and Data Collection

The questionnaire used was designed with reference to the recycling literature and the TPB theoretical framework (Tonglet, Phillips, & Read, "Using the theory of planned behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK", (2004a)) (Sidique, Lupi, & Joshi, 2010). In order to test the theoretical model proposed, the questionnaire was conducted among students at the University of Kelaniya, Sri Lanka. The questionnaire included questions about the respondents' eCycling willingness (eCycling Behavioral intention), Attitude toward eCycling, Subjective norms, Awareness of consequences, Perceived convenience, Perceived knowledge. The questionnaire also contained questions asking demographic information of the respondents. The dependent variable and all the independent variables are measured using a seven-point Likert-type scale with endpoints "Strongly Disagree= 1" and "Strongly Agree=7".

To enhance internal validity, pre-testing was conducted to modify the questionnaire before launching formally. Thirty copies of the questionnaire were randomly distributed in this pilot study. The main data collection was conducted in January 2017, during with 255 questionnaires were distributed in the university. 245 completed and valid questionnaires (response rate 96%) were returned.

This research was a preliminary study to gather data and test the constructs for recycling e-waste in light of previous research findings. In this study, SPSS software was used to evaluate data.

VI. RESULTS OF THE STUDY

The main purpose of this study was to analyze the factors that influence eCycling intention. In order to analyze the data, researcher has used the regression analysis. As it proves all the assumptions of regression analysis (Multicollinearity, Autocorrelation, Homoscedasticity, Normality) researcher has continued with the analysis. According to Table 01 all the factors i.e. Attitude toward eCycling, Subjective norms, Awareness of consequences, Perceived convenience, Perceived knowledge are significantly correlated to the dependent variable, eCycling willingness (eCycling Behavioral intention).

Among them, Perceived Convenience has the highest correlation with Behavioral Intention (Willingness) to eCycling which the value is 0.414. Perceived knowledge has the next highest correlation which is 0.302 and other 3 variables Attitude, Awareness of consequences, Subjective norms have a positive correlation of 0.268, 0.288 and 0.260 respectively. This indicates that all the five factors have a moderate positive association with Behavioral Intention (Willingness) to eCycling and association of all the five factors are significant under the 5% significant level.

Table 1:
Correlation analysis

		A	B	C	D	E	F
A	Pearson Correlation	1	.293**	.569**	-.080	**.268****	.132*
	Sig. (2-tailed)		.000	.000	.105	.000	.019
	N	245	245	245	245	245	245
B	Pearson Correlation	.293**	1	.332**	.543**	**.302****	.462**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	245	245	245	245	245	245
C	Pearson Correlation	.569**	.332**	1	-.015	**.288****	.232**
	Sig. (2-tailed)	.000	.000		.407	.000	.000
	N	245	245	245	245	245	245
D	Pearson Correlation	-.080	.543**	-.015	1	**.260****	.493**
	Sig. (2-tailed)	.105	.000	.407		.000	.000
	N	245	245	245	245	245	245
E	Pearson Correlation	.268**	.302**	.288**	.260**	1	.414**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	245	245	245	245	245	245
F	Pearson Correlation	.132*	.462**	.232**	.493**	**.414****	1
	Sig. (2-tailed)	.019	.000	.000	.000	.000	
	N	245	245	245	245	245	245

. Correlation is significant at the 0.05 level (2-tailed).
A – Attitude
B – Perceived knowledge
C – Awareness of consequences
D – Subjective norms
F – Perceived convenience
E – Behavioral intention (Willingness)

Multiple Regression Analysis

Multiple regression allows to determine the overall fit which means the variance explained of the model and the relative contribution of each of the factors to the total variance explained.
Tables 02 explains how well the regression model fits the data.

Table 02:
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.488	0.24	0.223	3.76926

R value is considered as one measurement of the quality of the prediction of dependent variable. So, R value of 0.49 describes a moderate level of prediction.

R square value of behavioral intention (0.240) showed the amount of variance in eCycling behavioral intention that could be explained by attitudes, Perceived knowledge, awareness of consequences, subjective norms, and perceived convenience.

According to the Table 3 the F-test is highly significant so it is assumed that there is a linear relationship between variable in this model.

Table 03:
ANOVA Table

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1063.751	5	212.750	14.975	**.000**
Residual	3395.553	240	14.207		
Total	4459.304	245			

Table 4 describes the unstandardized coefficient values and the significance of the independent variable to the dependent variable.

Table 04:
Coefficient Table

	standardized Coefficients B	Sig.
Attitude toward eCycling	.166	**0.020***
Perceived knowledge	.006	0.942
Awareness of consequences	.125	0.083
Subjective norms	.125	0.100
Perceived convenience	.299	**0.000***

Level of Significance 5 %

According to the above analysis, only two out of five independent variables were found as significant to the dependent variable. This describes that the Attitude toward eCycling and Perceived convenience have significant impact on eCycling intention (Willingness) while Perceived knowledge, Awareness of consequences and Subjective norms have minimum impact on willingness due to the less significant of the variables.

Test of Hypothesis

Table 05 shows the Hypothesis testing. H1 and H5 are accepted and H2, H3 and H4 Rejected.

Table 05:

Hypothese testing

Hypotheses	Accept/reject
H1: Attitude toward eCycling correlates to eCycling intention	**Accept**
H2: Perceived knowledge correlates to eCycling intention	Reject
H3: Awareness of consequences correlates to eCycling intention	Reject
H4: Subjective Norms correlates to eCycling intention	Reject

H5: Perceived Convenience correlates to eCycling intention	Accept

VII. Discussions and Conclusions

The TPB provided a useful foundation in explaining recycling behaviour. Attitudes and subjective norms significantly correlated with behavioral intention. This finding was consistent with those empirical studies in related areas, including those of Chen and Tung (2010), (Oom Do Valle, Rebelo, Reis , & Menezes, 2005), and Cheung et al. (1999). The additional measures of Perceived knowledge, awareness of consequences, and Perceived convenience were included in the model; these variables were also statistically significant in explaining the behavioural intention of recycling behaviour. The current study's result regarding Perceived convenience was consistent with the findings by (Tonglet, Phillips, & Read, "Using the theory of planned behaviour to investigate the determinants of recycling behaviour: a case study from Brixworth, UK", (2004a)).

This study gives insightful information to facilities management professionals as regards shaping a more user-friendly and convenient recycling scheme to fulfil the social responsibility for environmental protection. The results suggested that each of the five predictors – Attitude, Perceived knowledge, Awareness of consequences, Subjective Norms, Perceived Convenience – contributed approximately 25 per cent of R^2 in explaining behavioral intention. However, the contributions of all the variables were comparatively low. These findings implied that the key challenges and considerations for practitioners about the design and implementation of eCycling schemes.

This study developed a model to identify the determinants of eCycling intention vis-a `-vis eCycling activities in university in Sri Lanka. The results showed that out of five critical factors including eCycling intention were less influenced by only attitude, and Perceived convenience and that each of those five factors correlated positively with recycling intentions. This sheds light for facilities managers on the design and implementation of eCycling schemes in university.

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