Determinants Predicting Intention to Properly Dispose of Used Batteries

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ABSTRACT

Toxic metals are used in batteries which end up in landfill sites and which may reach humans via the food chain and food web. Proper disposal of used batteries is needed. However, the factors related to intention to proper disposal of used batteries need to be better understood. The purpose of this study was to examine relationship between any of these determinants: intention, attitude, subjective norm, perceived behavioral control, and exposure to information and the proper disposal of used batteries and to identify which of these determinants were predictors of the intention. Survey research was conducted using a self administered questionnaire among 3,652 Thammasat University students at the Rangsit campus. The sample was selected by a stratified random sampling technique. The results indicated that students who have a high and positive intention, high levels of subjective norm, and perceived behavioral control, and moderate level of positive attitudes were likely to practice a proper disposal of used batteries. Subjective norms, perceived behavioral control, exposure to information, and attitudes are statistically significant predictors of intention to dispose the used batteries in separate specific bins. Therefore, giving information by different innovations or activities on proper disposal of the used batteries and providing a specific waste bin for used batteries around campus are likely to encourage students to properly dispose their used batteries.

Keywords: used battery disposal, recycling, theory of planned behavior, intention to dispose used battery, college students

บทคัดย่อ

มนุษย์มักได้รับสารพิษจำพวกโลหะที่ผสมอยู่ในแบตเตอรี่พวกถ่านไฟฉายผ่านทางห่วงโซ่อาหาร จากการทิ้งซากแบตเตอรี่ปะปนกับขยะทั่วไป ปัญหาดังกล่าวแก้ไขได้ด้วยการผลักดันให้ทิ้งซากแบตเตอรี่อย่างถูกต้องซึ่งจำต้องเข้าใจอย่างชัดแจ้งว่าอะไรเป็น determinants ความตั้งใจที่จะทิ้งซากแบตเตอรี่อย่างถูกต้อง การศึกษานี้จึงมุ่งวิเคราะห์ปัจจัยตามทฤษฎีการกระทำอย่างมีแบบแผน (Theory of Planned Behavior) ได้แก่ ทัศนคติ บรรทัดฐานของสังคม และความเชื่อมั่นในตนเอง รวมถึงการได้รับข้อมูลข่าวสารเกี่ยวข้องกับความตั้งใจทิ้งซากแบตเตอรี่อย่างถูกต้องหรือไม่ นักศึกษามหาวิทยาลัยธรรมศาสตร์

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ศูนย์รังสิต 3,652 คนได้ตอบแบบสอบถามเกี่ยวกับปัจจัยดังกล่าว ผลการวิเคราะห์ชี้ให้เห็นว่านักศึกษามีความตั้งใจทิ้งซากแบตเตอรี่อย่างถูกต้อง มีทัศนคติบรรทัดฐานของสังคม และความเชื่อมั่นในตนเองที่จะทำพฤติกรรมดังกล่าว บรรทัดฐานของสังคม ความเชื่อมั่นในตนเอง การได้รับข้อมูลข่าวสาร และทัศนคติเป็นตัวทำนายความตั้งใจทิ้งซากแบตเตอรี่อย่างถูกต้องของนักศึกษา จึงควรที่จะจัดวางถังขยะสำหรับรองรับซากแบตเตอรี่เป็นการเฉพาะ และเชิญชวนให้ทิ้งซากแบตเตอรี่ลงถังที่รองรับเฉพาะซากแบตเตอรี่

คำสำคัญ: การทิ้งซากแบตเตอรี่ รีไซเคิล ทฤษฎีการกระทำอย่างมีแบบแผน ความตั้งใจ นักศึกษา

INTRODUCTION

Dry cells contain various kinds of toxic metals, i.e. cadmium, mercury, nickel, lithium, zinc, silver, and manganese (United States Environmental Protection Agency, 2001a, 2001b). These metals are harmful to human beings as well as to animals and plants. For example, cadmium can cause hypertension, depress immunity, increase cancer risk, and "itai-itai" disease (Haas, 2001). It is estimated that dry cell disposal amounts to more than 20 million kilograms per year in Thailand. Since there are no special facilities for handling these wastes, used dry cells generally are disposed of into the household waste bin and ended up at landfill sites (Ozaki, Sharma, Phanuwan, Fukushi, & Polprasert, 2003).

These disposal behaviors promote the contamination of heavy metals into the environment. Once they enter the environment via a landfill or incinerator, they will reach humans via water and/or the food chain (Fishbein, 2000; United States Environmental Protection Agency, 2001a, 2001b). Studies in Thailand suggest that contamination of the environment of some heavy metals from solid waste disposal or wastewater treatment plants has occurred in some areas. For example, the contamination of leachate from the old Kukot sanitary landfill into groundwater affected the concentration of lead, and cadmium in the groundwater at 0.37, 0.047 ppm higher than the standard level of ≤0.05, ≤0.01 ppm, respectively (Soonthondecha, 2003). A study of underground water quality from On-nuch solid waste disposal area in 1996 has indicated that the concentration of mercury and cadmium exceeded the standard level (Changjaturus, 1996). In addition, lead amounts in mangrove snails (*Cassidula sp.*) at Leam Pak Bia mangrove area receiving treated wastewater from Phetchaburi municipal treatment system has been reported at 1.034 mg/kg, exceeding the standard level at 1 mg/kg (Somyoonsap, 2001). Though it cannot be concluded that those contaminations exceed the safety level and those in the fauna are caused directly from batteries, it does suggest the possibility of contamination and that prevention and control measures should be considered and implemented.

Three R measures - reduce, reuse, and recycle - are believed to potentially reduce contamination (Jibril, Sipan, Sapri, Shika, Isa, & Abdullah, 2012). Reducing the use of batteries is probably not effective since it contradicts user convenience and demand. Reuse is implemented by promoting the use of rechargeable batteries but those rechargeable batteries also contain toxic metals. Recycling which means the collection of used batteries to extract some metals for the production of new batteries is considered to be the most effective measure (Fishbein, 2000). This method requires the cooperation of users in the proper disposal of used batteries in specific separated waste bins (Xuan, Baotong, & Hua, 2011).

The theory of planned behavior (TPB) is popular in recycling studies (Chen & Tung, 2010; Davies, Foxall, & Pallister, 2002; Do Valle, Reis, Menezes, & Rebelo, 2004; Hansmann, Bernasconi, Smieszek, Loukopoulos, & Scholz, 2006; Kelly, Mason, Leiss, & Ganesh, 2006; Knussen, Yule,

MacKenzie, & Wells, 2004; Kurz, Linden, & Sheehy, 2007; Mahmud & Osman, 2010; Tonglet, Phillips, & Bates, 2004a; Tonglet, Phillips, & Read, 2004b; Tudor, Barr, & Gilg, 2008). The theory concerns with the relationship between beliefs, attitudes, subjective norms, perceived behavioral control, and intention which leads to behavior. The most significant determinant of behavior is a person' s intention which is determined by their attitudes toward performing a given behavior, their subjective norm and their perceived behavioral control of that behavior (Montano & Kasprzyk, 2008).

A significant relationship between attitudes toward recycling and intention to recycling behavior has been reported in many studies (Chen & Tung, 2010; Davies, Foxall, & Pallister, 2002; Do Valle, Reis, Menezes, & Rebelo, 2004; Hansmann et al., 2006; Kelly et al., 2006; Knussen et al., 2004; Kurz et al., 2007; Mahmud & Osman, 2010; Tonglet et al., 2004a; Tonglet et al., 2004b; Tudor et al., 2008). According to the theory of planned behavior, attitudes, subjective norms and perceived behavioral control are predictors of intention. This is supported by many studies (Chen & Tung, 2010; Davies et al., 2002; Knussen et al., 2004; Mahmud & Osman, 2010; Mannetti, Pierro, & Livi, 2004; Oreg & Katz-Gerro, 2006; Sidique, Lupi, & Joshi, 2010). However, some studies showed controversial results (Cheung, Chan, & Wong, 1999; Davies et al., 2002; Mannetti et al., 2004; Tonglet et al., 2004b).

All of the previous studies focused on valuable recycling materials, i.e. paper, glass, metals, and plastics but used batteries are not included. This may be due to the society's value that used battery has no monetary value in the recycle industry. On the contrary, the used batteries are toxic to all living things. In the present study it was hypothesized that attitudes, subjective norms, and perceived behavioral control to proper disposal of used batteries may be predictors of intention to dispose used batteries into specific recycling waste bins. In addition to attitudes, subjective norms and perceived behavioral controls the present study added, another concept i.e. exposure to information on health.

Thammasat University (TU), Rangsit campus consists of around 20,000 students, and teaching and support staff who use dry cells in various personal electric and electronic divices. A preliminary study using a self administered questionnaire among 150 students revealed that all of them generated used dry cells. Eighty-seven percent of used dry cells were disposed of in the general household waste at their home, while 13% were disposed of in general waste at TU. Twenty-six percent of respondents disposed of used batteries every 4 months, 19% disposed of batteries every 1 to three month, 14% disposed of used batteries every 1 week, and the remaining disposed of in various frequencies. A preliminary study among 150 Public Health students revealed that alkaline batteries are the most popular of which 20.7 ±24.0 units are used per person per year. Nickel-cadmium batteries were the second most popular and 6.9±13.7 units were used per person per year. Nickel metal hydride and Lithium batteries were used 1.0±4.1 and 4.8±10.1 units per person per year, respectively. From those preliminary data, it was estimated that all students disposed of dry cells around 660,000 units a year. If this behavior still remains, the contamination of toxic metals in the environment will be increased and will be transported to humans through the food chain and/or drinking water. Although a recycling program was launched in 2007, used batteries were not included (Thammasat University, 2008). Therefore, if we wish to promote proper disposal of used batteries among students, we need to know their intention and associated Theory of Planned Behavior constructs.

This study aims to examine factors influencing disposal of used batteries. Those factors include intentions, attitudes, subjective norms, and perceived behavioral control In addition, of those factors, which is the significant predictors are also identified through a regression statistical analysis method. Results will be used for developing an intervention for behavioral change to prevent

diseases caused by toxic metals and to preserve our environment. This study was approved by ethics committee of Faculty of Public Health, Mahidol University.

MATERIALS AND METHODS

Participants

Twenty percent of undergraduate students, 3,652 persons, studying at Thammasat University, Rangsit campus participated in the study. The sample was stratified in proportion to the total number of all students studying in each faculty and by the year of study. The sample was taken using blind selection technique.

Procedure

The survey was designed to identify the predictors of used battery disposal intentions of undergraduate students at Thammasat University, Rangsit campus. The self-administered questionnaire was distributed to the samples through the student affairs staff of each faculty. The completed questionnaires were returned within two weeks.

Measurements

A set of paper-based self-administered questionnaire was constructed using the TPB questionnaire format (Ajzen, 2006; Francis et al., 2004). The following items were measured in the questionnaire: intentions, attitudes, subjective norms, perceived behavioral control, exposure to information, socio-demographic variables, and using battery behavior. All questions were in the Thai language.

Intention: Four items were used to measure intention. Participants rated the following statements on a seven-point "agree-disagree" scale: "I will dispose of my used batteries in a specific recycling bin, if available, every time I have a used battery" "I want to dispose of my used batteries in a specific recycling bin, if available, every time I have one to be disposed off" "I intend to dispose of my used batteries in a specific recycling bin, if available, every time I have one for disposal" and "I plan to dispose of my used batteries in a specific recycling bin, if available, every time I have one for disposal".

Attitude: A seven-point scale was used to directly measure attitudes concerning proper disposal of used batteries. The attitudes identified were: Dispose of used batteries in specific waste bins is "good/bad"; "useful/a waste of time"; "responsible/not responsible"; "sensible/not sensible"; "beneficial/harmful"; "pleasant/unpleasant".

Subjective norms: Subjective norms refer to social pressure to properly dispose of used batteries and were assessed by four questions: "Most people who are important to me think that I should/should not dispose of my used batteries into a specific recycling bin," "It is expected of me that I will dispose of used batteries in a specific recycling bin.," "I feel under social pressure to dispose of used batteries into a specific recycling bin," and "It is expected of me that I dispose of my used batteries into a specific recycling bin".

Perceived behavioral control: Seven-point "agree-disagree" scales or incomplete question with 7-point scales of easy-difficult were used to directly measure perceived behavioral control of both capability and controllability. The items included are: "I am confident that I can dispose of used batteries into a specific recycle bin". "For me to dispose of used batteries into a specific recycle bin (easy/difficult)". "The decision to dispose of used batteries into a specific recycling bin is beyond my control". "Whether I dispose of used batteries into a specific recycling bin is entirely up to me".

Exposure to information: The exposure to information questions were incorporated into the questionnaire as follows: "I know from a class that used batteries must be disposed of into a separate specific waste bin". "I know from my friends that used batteries must be disposed of into a separate specific waste bin". "I know from the mass media that used batteries must be disposed of into a separate specific waste bin".

Socio-demographic variables included were: gender, name of faculty in which respondents were studying, and year of study

Using battery behavior included: List of electric and electronic appliances consumed energy from battery, type of battery, frequency of battery change, and place for disposing of used batteries.

Assessment of the instrument

Questionnaires were tried out with at least 20 students in order to ensure item clarity and non-ambiguity. The item(s) that were difficult to answer were modified and the wording was revised and retested. Cronbach's alpha coefficients were computed to measure internal consistency. Some items were deleted to increase coefficients to 0.6 or more (Francis et al., 2004). Cronbach's alpha of intention, attitude, subjective norms, perceived behavioral control, and exposure to information are 0.904, 0.663, 0.867, 0.752, and 0.778 respectively.

Data analysis

Each questionnaire was coded and entered into a computerized data set. The items that had been negatively worded were recorded by reversing the scores. An average score for attitudes, subjective norms, and perceived behavioral control were calculated using the summated scores of all items for each construct. A high score consistently reflected more positive attitudes, subjective norms, and perceived behavioral control. The direct measured constructs and exposure to information were tested to be predictors of intentions by multiple regression technique at a 95% confidence level.

RESULTS

One thousand four hundred and thirty two completed questionnaires (39.2%) were returned. The demographic data of responding students are 66.6 percent female and 33.4 percent male. They are freshmen 28.5 percent, sophomore 26.5 percent, junior 25.8 percent, senior 17.5 percent, fifth year of study 1.1 percent and sixth year of study 0.6 percent. Fifty-one percent studied Social Science and Humanities, 30.4 percent studied Science and Technology, and 18.5 percent studied Health Science.

The Average score of the Direct Measured Constructs

The calculation from all direct questions about intention to dispose of used batteries in a specific waste bin showed the average score of 5.42 ± 1.14 (on a 7 points rating scale). The average score of attitude to dispose of used batteries in a specific waste bin was 4.58 ± 0.71. The average score of subjective norms about disposal of used batteries in a specific waste bin, was 5.37 ± 1.12. The average score of over perceived behavioral control about disposal of used batteries in a specific waste bin was 5.48 ± 1.15. These average scores show that the students have high scores for intention, subjective norms, and perceived behavioral control and medium scores on attitude.

Correlation among study variables

The relationship among all study variables were analyzed by correlation (Table 1). All show positive relationship with rather low value of Pearson correlation coefficient but significant at the 0.01 level. However, one of seventeen variables, Attitude4 (ATT4), show a negative correlation with all exposure to information because this item asked for their thought on how to disposed the used batteries despite non existence of the specific bin. Therefore it is possible to reflect negatively on this item.

Prediction of intention to use specific recycle bin

Stepwise multiple regression was performed to test the relationship among those constructs. The results revealed that subjective norms made a significant contribution in explaining the magnitude of intention to separate or dispose the used battery in a specific recycle bin. The other significant variables were perceived behavioral control and exposure to

information. Attitude also made a significant contribution in improving the predictive ability of the model. About 51 percent of the variance of the intention score can be explained by attitude, subjective norms, perceived behavioral control, and exposure to information (Table 2).

DISCUSSION

Four out of ten (40%) surveyed students completed and returned the questionnaires. Compared to males there were twice as many females who responded, which is the normal gender

Table 1 Correlation matrix among variables and Range, Means, and Standard Deviation for each study variables

	INT2*	INT3*	INT4*	ATT1*	ATT3*	ATT4*	ATT5*	ATT6*	SN1*	SN2*	SN4*	PBC1*	PBC3*	PBC4*	SF4*	SF5*	SF6*
INT2	1	.497**	.557**	.455**	.373**	.121**	.447**	69**	.460**	.317**	.432**	.624**	.358**	.261**	.324**	.231**	.266**
INT3		1	.513**	.298**	.319**	.007	.306**	.226**	.401**	.354**	.419**	.510**	.277**	.223**	.337**	.230**	.257**
INT4			1	.453**	.415**	.091**	.467**	.246**	.529**	.362**	.438**	.613**	.335**	.270**	.364**	.249**	.319**
ATT1				1	.371**	.343**	.621**	.286**	.466**	.248**	.393**	.626**	.498**	.375**	.289**	.102**	.200**
ATT3					1	.125**	.361**	.245**	.385**	.356**	.335**	.429**	.290**	.240**	.290**	.207**	.197**
ATT4						1	.337**	.254**	.129**	.037	.101**	.208**	.200**	.094**	-.023	-.091**	-.108**
ATT5							1	.246**	.519**	.278**	.431**	.565**	.462**	.333**	.256**	.127**	.213**
ATT6								1	.257**	.156**	.218**	.335**	.207**	.101**	.120**	.044	.083**
SN1									1	.384**	.543**	.546**	.423**	.330**	.357**	.237**	.321**
SN2										1	.396**	.372**	.231**	.184**	.322**	.263**	.273**
SN4											1	.482**	.384**	.251**	.329**	.260**	.287**
PBC1												1	.462**	.337**	.334**	.200**	.257**
PBC3													1	.476**	.229**	.116**	.174**
PBC4														1	.251**	.100**	.216**
SF4															1	.301**	.416**
SF5																1	.308**
SF6																	1
Range	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7	1-7
Means	5.40	5.64	5.23	5.61	5.65	5.02	5.63	4.964	5.34	5.27	5.51	5.11	5.76	5.56	5.00	4.99	4.99
S.D.	1.401	1.325	1.431	1.486	1.448	2.010	1.515	1.719	1.400	1.504	1.353	1.531	1.407	1.490	1.699	1.784	1.711

*Abbreviation: INT=intention, ATT=attitude, SN=subjective norms, PBC=perceived behavioral control, and SF=situational factor
** $p < .01$

Table 2 Regression analyses predicting intention to use specific recycle bin

variables	B	SE	*p*	R^2
constant	0.608	0.151	<0.001	
Subjective norms	0.346	0.025	<0.001	0.396
Perceived behavioral control	0.317	0.023	<0.001	0.483
Exposure to information	0.136	0.019	<0.001	0.503
Attitude	0.119	0.035	0.001	0.508
R^2	0.508			

distribution among Thammasat University students. Freshmen, sophomores, and juniors are nearly equal in number, i.e. one fourth of the population. There were fewer senior respondents due to some who had graduated early. There are only a few who were studying in the fifth and sixth years. They are those from the Medicine and Dentistry faculties.

When classifying the mean value of the studied factors into high, moderate and low levels, results indicated that the means scores of the intentions, subjective norms and perceived behavioral control were higher than that of the attitude score. This results suggests that those students who have are likely to proper dispose their used batteries are influenced by the subjective norm and perceived behavioral control. Subjective norms in this case includes friend, professors, university administrator, and mass media who are giving information to them in class, and university policy announcement and the public. Even though their attitude is at the lower level than the subjective norms and perceived behavioral control, but it is also have a statistical significant association.

Results from multiple regression analysis supported the applicability of Theory of Planned Behavior to understand intention concerning the proper disposal of used batteries. The relationship among all direct measured constructs: attitudes, subjective norms, and perceived behavioral control, and intention were statistically significant.

This intention may result from exposure to information on the environment and health from their classes, friends, or media which affected attitudes and perceived behavioral control (Bartholomew, 2006). However, if facilities to dispose of used batteries are supported and a campaign for separate waste is launched, the average score of these constructs may become much higher. In Thai culture, people normally are educated to care for other people. This cultural influence may cause their high subjective norms. This suggests that students intend to dispose of used batteries in a separate specific waste bin.

According to the theory of reasoned action, if people evaluate the suggested behavior as positive (attitude), and if they think their significant others want them to perform the behavior (subjective norm), this results in a higher intention (motivations) and they are more likely to do so. A high correlation of attitudes and subjective norms to behavioral intention, and subsequently to behavior, has been confirmed in many studies (Berger, 1997; Davis, Phillips, Read, & Iida, 2006; Mannetti, et al., 2004).

A counter-argument against the high relationship between behavioral intention and actual behavior has also been proposed, as the results of some studies show that, because of circumstantial limitations, behavioral intention does not always lead to actual behavior. Namely, since behavioral intention cannot be the exclusive determinant of the behavior where an individual's control over the behavior is incomplete, Ajzen introduced the theory of planned behavior by adding a new component, "perceived behavioral control." By this, extension of the theory of reasoned action to cover non-volitional behaviors for predicting behavioral intention and actual behavior (Montano & Kasprzyk, 2008).

This suggests that those constructs are predictors of intention to properly dispose of used batteries (Francis et al., 2004). These three components explained 48.9 percent of the variance in recycling intention. This is similar to Cheung et al. (1999)'s study of university students who studied with wastepaper recycling. They found that these components explained 54.4 percent of the variance, a little higher than results of this study. Even though both the study were done in university students, but the recycle material were completely different. Wastepaper was the second largest portion of municipal solid waste and have quite a high recycling rate while the used battery, dry cells, was a small portion of municipal solid waste and nearly without recycling in Thailand.

This indicated the potential to recycle used battery of the student if separate specific waste bins will be supplied. Those of three constructs can

predict the intention the same as Tolma, Reininger, Evans, and Ureda (2006)'s study and Kakoko, Astrom, Lugoe, and Lie (2006)' s study which lower percent of explained variance, i.e. 26.7 percent (Tolma et al., 2006) and 12 percent (Kakoko et al., 2006). Because those studies performed in different populations and behavior, i.e. general population and sensitive behaviors – mammography screening and use of voluntary HIV counseling and testing service, respectively.

In contrast, the results of the present study were different from those of Tonglet, et al. (2004a, 2004b) who found that only attitude was a predictor of intention. This also is different from Bledsoe's results (Bledsoe, 2006) who found that only attitude and subjective norms were predictors of intention.

The results of the present study also suggested that the students received information from the significant others which is Professors in their class and peers or classmates is crucial in influencing them to value the disposal of used batteries behavior in the college context. All students reported being educated about environmental conservation and recycling behavior from their studies in high school and their first year of study in the university, therefore exposure to information was an implicit predictor of the proper used battery disposal intention through the subjective norms.

If explained from the situational or environmental factors in comparing with other studies that applied the theory of reason action or theory of planned behavior, this study finding is slightly different from others in the sense that attitude has a lower contribution to the intention. This may be due to the insufficient supply of specific waste bin throughout the TU campus. Therefore learning from professors and peers may not be strong enough to influence attitude change. Otherwise the association may be at a higher level.

This study also found that subjective norms, perceived behavioral control, and attitudes were predictors of intention to dispose of used batteries in specific separate waste bins. Any innovation or intervention for intrapersonal behavior change such as mastery experience or vicarious experience (McAlister, Perry, & Parcel, 2008) through modeling as a way to influence cultural changes should be encouraged to develop by the college students themselves so that they can be more persuasive and their attitude change will then lead to a higher intention level as well. These methods are, for example, persuasive communication, active learning, feedback, facilitation, and modeling, etc. However, these constructs are related to beliefs (Fishbein & Ajzen, 2010). A combination of methods is more likely than a single method to have a behavioral effect (Schult, Oskamp, & Mainieri, 1995). Therefore, the methods which change attitudes, subjective norms, and perceived behavioral control should be advocated to combine with the above mentioned methods as effective interventions for example, feedback, modeling, commitment, and motivation (Bartholomew, Parcel, Kok, & Gottlieb, 2006; Schultz et al., 1995).

CONCLUSION

It can be concluded that student's intention influenced by high level of subjective norms, and high level of perceived behavioral control on proper disposal of used batteries even though the attitude is at the moderate level. Subjective norms through the exposure to information from the professor and peers, perceived behavioral control, and attitudes are good predictors of intention to dispose of used batteries in separate specific bins. It is recommended that specific separate waste bins throughout the campus and a combination of intrapersonal behavior change activities is likely to help increasing the disposal of used batteries behavior among the college students.

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