Plastic Bag Management Options in Phnom Penh, Cambodia

Septorm Koeng*, Alice Sharp, Seingheng Hul, and Fidero Kuok

***Abstract*—** *Plastic waste composition in Phnom Penh dramatically increased from 6% in 1999 to 21.2 % in 2016. Plastic bag use also increased. A study in 2015 has shown that the urban Cambodian people use more than 2,000 plastic bags each year (on average) which is 10 times higher than the European Union. Although the country recently issued a policy on plastic bag management, the enforcement is very limited. Therefore, further intervention is needed to improve plastic bag management in Phnom Penh. In this study, 160 questionnaire surveys were conducted to identify the behavior and knowledge of plastic bag consumption of the citizens so that policy options can be proposed. The result has shown that 90.9% of people disposed of plastic bags with another type of waste. Related to the proposed policy options, 43.2 % chose alternative materials. Charging a fee for plastic bag use and banning plastic bag consumption were 28.6 % and 28.2%, respectively. Thus, it is not an acceptable solution to ban the plastic bag consumption in Phnom Penh, currently. The proposed policy options are mixed policies such as charging a fee for plastic bag use, promoting alternative materials, and improving awareness and education.*

***Keywords*— Plastic bag, Waste management, Knowledge and perception, Cambodia, Phnom Penh.**

1. INTRODUCTION

Municipal solid waste management (MSWM) is a major problem in urban areas around the world, especially in the fast-growing towns and cities of developing countries. The poor management of solid waste could cause environmental health hazards in these cities and their surrounded areas [1].

For Asian countries, solid waste management has emerged as a major concern. Therefore, a large amount of the budget is used to operate a solid waste management system in each city. In the last decade, the quantity of generated waste has significantly risen in cities of Asian nations due to the changes in the standard of living, rapid economic growth, and industrialization [2].

Solid waste management is greatly influenced by several factors including politics, laws, socio-economy, available resources, and technical problems [3].

MSWM in most cities of developing nations has resulted in environmental pollution, especially surface and groundwater contamination which could become a serious human health risk [4].

The MSWM in Phnom Penh is still limited due to several major challenges such as the legal system, financial support, human resources, waste management facilities, environmental education, and management of waste scavengers [3, 5, 6]

Waste management authorities and relevant institutions in Phnom Penh (Cambodia) find it difficult to handle the proper management of plastic waste, especially plastic bags. As a result of rapid population growth and economic development, the annual quantity of generated solid waste in Phnom Penh rose from 409,335.64 tonnes in 2010 to 808,529.99 tonnes in 2017 [7]. With a large change in waste generation, the municipal solid waste composition has also changed. For example, the plastic waste increased about 3 fold from 6% in 1999 [8] to 17.8% in 2013 [9], 20.9% in 2015 [10], and 21.2% in 2016 [11]. For plastic waste, the municipal plastic bag composition was 15.8% and household plastic bag composition was 14.2% in 2015 [10]. Moreover, the non-household plastic bag composition was 13.5% in 2014 [12].

The plastic waste composition has significantly increased in the last decade. The major composition of plastic is from plastic bags, which accounted for 75.5% of the total plastic waste. White plastic bags were 51.9%. There were 23.6% colored plastic bags, and other plastic bags (24.5%) [10].

Plastic retail shopping bags are defined as “bags provided by retailers (free of charge) to customers as a mean of transporting merchandise” [13]. Plastic bags are made from non-renewable resources [14]. The major ingredient in plastic manufacturing is petroleum and natural gas. Moreover, plastic bags commonly are manufactured from one of three basic types of polyethylene such as high-density polyethylene (HDPE), low-density polyethylene (LDPE), or linear low-density polyethylene (LLDPE) [15]. Plastic bags are generally used for shopping since they are cheap, light, sturdy, plentiful, and convenient to carry [16, 17], The global plastic bag consumption has reached 500 billion to one trillion bags each year. [17, 18]. The improper disposal of plastic bags after consumption could cause harm to the

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natural environment and ecosystem [19]. Major environmental problems include visual pollution, blocked drainages resulting in flooding, death of livestock and animals, decrease in soil productivity in agricultural areas, release of toxic substances such as furan and dioxin by burning, and becoming a breeding ground for mosquitos which can spread malaria [20]. Furthermore, it takes between 400 to 1,000 years for a plastic bag to break down [21].

A research study in 2015 carried out by the anti-poverty organization reported that about 10 million plastic bags were consumed daily in Phnom Penh. Moreover, on average, the urban Cambodian people use more than 2,000 plastic bags (per capita) each year which is 10 times higher than the European Union and China. [22], [23].

Solid waste management sub-decree 36 was issued by the Cambodia Royal Government on 27 April 1999. Cambodia did not have any other legislation, policies, or regulations on plastic and plastic bag management until the sub-decree on plastic bag management was issued on 10 October 2017. The main goal of this sub-decree is to enhance the effectiveness of the reduction, import, production, distribution, and consumption of plastic bags, to ensure the public health, environmental protection, and aesthetics. Some large and modern supermarkets have followed and implemented this sub-decree by charging an additional fee of 400 Riel (0.10 USD) per plastic bag if a customer asks for a plastic bag. The recent sub-decree is an effective option for improving plastic bag management. However, this policy introduces a new concept to the Cambodian people because of their limited knowledge and awareness of the negative impact of plastic bags and proper plastic bag management. However, there is still some concern about the effectiveness of policy implementation, especially on a large scale such as in traditional markets, grocery shops, and street stalls. If effective plastic bag management does not start quite soon, there will be a huge negative impact of plastic bags on the environment, economy, and human health in the future. Therefore, it is important to assess the behavior and knowledge of plastic bag consumption of people in Phnom Penh. The objective of this study is to understand the behavior, perception, and knowledge of people regarding plastic bag consumption so that management options can be proposed for improving the plastic bag management in Phnom Penh.

2. METHODOLOGY

2.1 Study Area

This research study was conducted in Phnom Penh, the capital and largest city of Cambodia. It is commonly known as a center of security, politics, economics, cultural heritage, and diplomacy. Phnom Penh consists of 12 districts, including 4 urban districts (Doun Penh, Toul Kouk, Prampir Makara, Russey Keo, Chamkar Mon) and 8 rural districts (Saen Sokh, Mean Chey, Por Senchey, Dangkao, Chroy Changva, Chebar Ampov, and Prek Pnov).

Due to data availability, this study covers 6 districts as described in the next section. The population of Phnom Penh grew by 12.4% between 2008 and 2013, from 1,501,725 to 1,688,044 people [24]. The map of the study area is shown in Fig. 1.

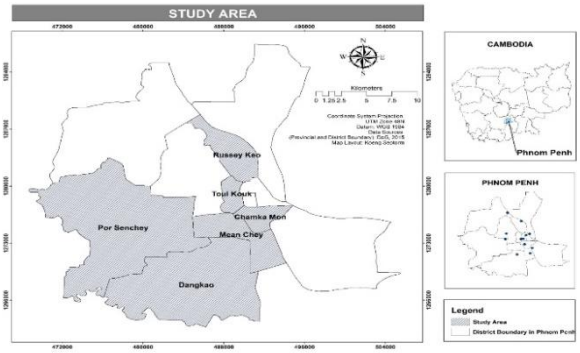

Fig. 1. Map of Phnom Penh and the selected districts of the survey.

2.2 Data Collection

2.2.1 District Selection

In this study, we selected 2 urban districts, namely, Tuol Kouk and Chamkar Mon. They are located in central Phnom Penh and represent 4 districts in the urban areas. For rural districts, we selected 4 districts out of 8 districts in different locations (Russey Keo in the north, Dangkao in the South, Por Senchey in the West, and Meanchey in the East). We chose this method to justify that our samples represent the whole population in different parts of Phnom Penh. The number of respondents of each district is based on the population of each district.

2.2.2 Household sampling method

A random sampling method was applied in this study for the household survey. Under this sampling design, every item of the universe has an equal chance of inclusion in the sample. In this study, first, the stratified sampling method was conducted in each district, which was divided into different blocks called “strata”. Then, a systematic sampling method was applied to identify which households should be selected for interviews by setting a 200-meter interval from each household.

2.2.3 Sample size calculation

The sample size for the household survey is calculated based on Cochran’s formula for calculating the sample size when the population is infinite. Cochran (1977) developed a formula to calculate a representative sample, as Equation (1).

$$n_0 = Z^2 Pq/e^2 \quad (1)$$

where

n_0: sample size

Z: selected critical value of the desired confidence level,

P: estimated proportion of an attribute that is present in the population, assuming a maximum variability of 50% (p =0.5)

e :desired level of precision

q = 1-p

In our study:

Z = 2.58 ,99% confidence level

P = 0.5

E = 0.1=10% error

q = 1− *0.5=0.5*

As a result:

$$n_0 = (2.58)^2 \text{ x } (0.5 \text{ x } 0.5)/ 0.1)^2 = 166$$

Therefore, the needed samples for this household survey are 166 samples.

2.2.4 Design Questionnaire and Data Analysis

The questionnaire contains 3 main sections. The first section consists of general information about household and socio-economic status (education, occupation, and income). Second, we ask people about plastic bag consumption behavior, including the number of plastic bags they generated, whether they reduce and reuse the plastic bags or not, and how they deal with plastic bag waste. Third, we question the respondents about knowledge, perception, and awareness of plastic bag consumption. Regarding the data analysis, we input and analyze the data by using the Statistical Package for the Social Science (SPSS) Version 21.

3. RESULTS AND DISCUSSION

3.1 Demographic Profile of Respondents

The survey was conducted through a questionnaire with 166 households. It was found that a majority of the respondents was female (81.4%). Regarding education, 70 % of respondents have a basic educational background from primary school to high school, followed by higher education at 21.7%, and 8% do not have a basic education. Details of the information are shown in Table 1.

Table 1. Demographic Profile of Respondents

Social demography variable	Frequency	Percent	Cumulative percentages
Gender			
Male	33	18.6	18.6
Female	144	81.4	100
Total:	177		
Age (years)			
<25	20	11.3	11.3
25-35	65	36.7	48.0
36-50	52	29.4	77.4
51-85	40	22.6	100.0
Total:	177		
Education			
Never enrolled	14	8.0	8.0
Primary school	43	24.6	32.6
Secondary school	40	22.9	55.5
High school	40	22.9	78.4
Bachelor's degree	36	20.5	98.9
Master's degree	2	1.1	100
Total:	175		
Occupation			
Government official	11	6.4	6.4
NGO staff	3	1.7	8.1
Private institution staff	22	12.7	20.8
Student	16	9.2	30.1
Private business	103	59.5	89.6
Homemaker	18	10.4	100
Total:	173		
Monthly income			
100-200$	45	31.7	31.7
201-400$	60	42.3	74.0
401-600$	25	17.6	91.6
601-1000$	6	4.2	95.8
1001-1500$	5	3.5	99.3
1001-1500$	1	0.7	100
Total:	142		
Status of the house			
Own	92	56.4	56.4
Rent	71	43.6	100
Total:	163		
Duration of staying in the residential area (years)			
<5	59	33.6	33.6
5-10	47	26.7	60.3
11-20	21	11.9	72.2
> 20	49	27.8	100
Total:	176		

3.2 People behavior of plastic bag consumption

The major reasons for people to use plastic bags are shown in Fig. 2**.** Nowadays, the first most likely reason people like using plastic bag is because it is convenient for packing shopping items, which accounted for 64.8%. Plastic bags are convenient, cheap, easily accessible, and ubiquitous [25]. The second reason is that plastic bags are free of charge, which accounted for 13%. Consumers consider that the cost of a plastic bag is already included in the price of the purchase [26]. As the plastic bags are offered free of charge, the environmental damage of plastic bags (which is an external cost) is not internalized into their true cost [16]. Therefore, governments and people should not ignore the negative impact of plastic bags on the environment. Some policy options to solve the plastic bag problem should be proposed.

In this situation, introducing a fee for plastic bags could be an effective method for reducing the plastic bag consumption in Cambodia. This policy has been implemented in several countries [27-29]. In fact, in Cambodia, some large and modern shopping malls and supermarkets have implemented a fee for plastic bags according to sub-decree number 168 of the plastic bag management act of 2017. To be more effective, a fee for plastic bags can be implemented throughout a country, especially in small markets and groceries. In Cambodia, the business and special retail sectors consumed the largest quantity of plastic bag. Plastic bags serve their main function as a carry bag and value-added function. Retail activities could be both consumer and wholesale [26]. However, to achieve such a difficult goal, Cambodia may need more time.

Readily and easily available plastic bags accounted for 6% in Phnom Penh. In Gawahati, India, they accounted for 60 % [30]. In Maun, Botswana, they accounted for 39.6% [31]. In another study in Swat, Kpk, Pakistan, they accounted for 50.7% [32].

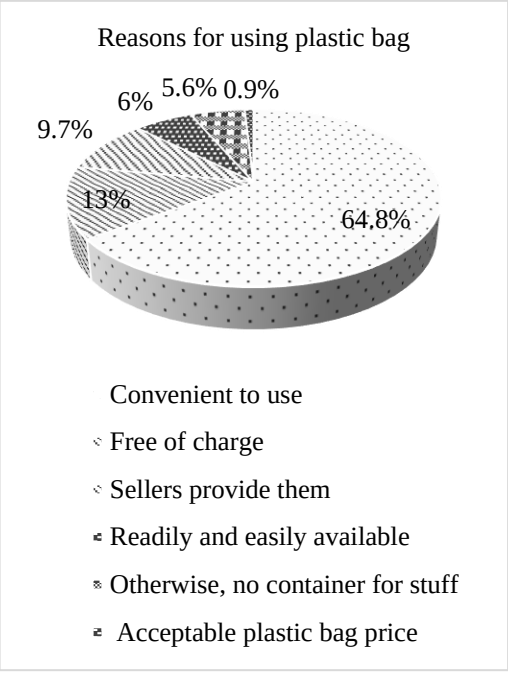

Fig. 2. Reasons for using plastic bags.

In this study, an acceptable price of the plastic bag accounted for 0.9%. However, the reason plastic bags are used excessively in India, Pakistan, and Botswana is that the price of plastic bags is cheap, accounting for 42%, 38.9% and about 30%, respectively [30-32]. If the price of an alternative material is low enough, the material would be accepted by more customers [26].

After they have received plastic bags, most of the respondents (91.9 %) have realized that they have received many plastic bags. In addition to this, the majority of people answered that they reduced plastic bag use and reused the plastic bags, 76.7 % and 77.4 %, respectively. However, up to 96.6 % did not collect the plastic bags for sale due to the limited market and the very cheap price of plastic bags. The detailed information is shown in Table 2.

Table 2. Reduce, reuse, and collect plastic bags

Questions	N	Percentage	
		Yes	No
Q.1.1 Have you received many plastic bags?	161	91.9	8.1
Q.1.2 Have you reduced your use of plastic bags?	176	76.7	23.3
Q.1.3 Do you reuse the plastic bags?	177	77.4	22.6
Q.1.4 Do you collect the plastic bags to sell?	176	3.4	96.6

Table 3. Reasons for reducing the use of plastic bags

Reasons for reducing the use of plastic bags	Responses	
	N	Percent
Reduce the impact of plastic bags on the environment	116	78.4
Promote an alternative product instead of plastic bags	6	4.1
There is a lot of rubbish in my house	8	5.4
They make my house messy	8	5.4
I can save money	10	6.7
Total:	148	100.0

As shown in Table 3, there were some reasons that people reduced their use of plastic bags. People are aware of the negative impact of plastic bags on the environment, which accounted for 78.4%. Therefore, when education and awareness are provided more widely, people react to the benefits for the environment. However, awareness of any issues does not guaranty a conversion to the desired activities. Moreover, awareness of potential environmental degradation does not make

any noticeable changes in the behavior of plastic bag consumption of the local people. People, including consumers and vendors, still use too many plastic bags. Therefore, the nature of the message and a lack of systems that can support positive activities may contribute to this overuse of plastic bags [26].

Fig. 3 describes some reasons that people do not reduce their use of plastic bags. Many people (71.4%) replied that it is difficult to find other materials to use instead of plastic bags. This finding is consistent with the study in India and Botswana. A reason for using plastic bags is a lack of convenient alternatives, which accounted for 42% in India and 11.2% in Botswana [30, 31]. This could be a suitable excuse for people not to reduce their use of plastic bags. Although we could not avoid or stop using plastic bags due to their functions, there are some simple methods for reducing the use of plastic bags such as bringing their own bags, and using alternative products for packing when it is possible (for example banana leaves, lotus leaves, and paper). Biodegradable plastic bags and other alternative materials could be encouraged and produced in Cambodia.

To improve the management situation, alternative materials have to be available and easy to access (both price and location to buy). If it is convenient, people may change their behavior.

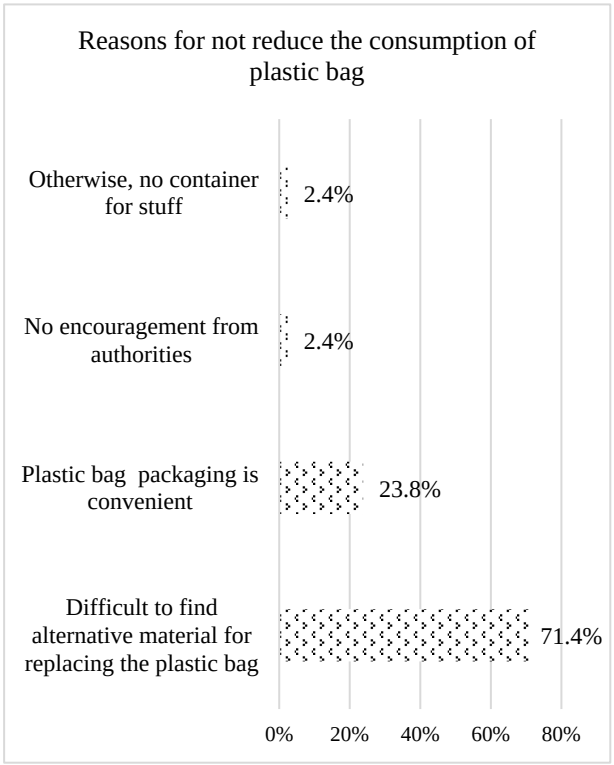

Fig. 3. Reasons which people do not reduce the consumption of plastic bags.

As stated in Table 4, people tend to reuse plastic bags mainly for different purposes that could provide them some benefits, for example, to pack solid waste and pack some stuff. When they reuse plastic bags, they get benefits from them and reduce the number of plastic bags that end up in the environment or in landfills. If plastic bags are dirty, they will be disposed of with other types of waste.

Table 4. Reasons for reusing plastic bags

Reasons for reusing plastic bags	Responses	
	N	Percent
For other purposes	91	47.4
Not wasting plastic bags	41	21.4
Saving money	33	17.2
Reducing the number of plastic bags in the environment and landfills	14	7.3
Reducing the negative impact of plastic bags on the environment	9	4.6
Using the plastic bags to carry waste	4	2.1
Total:	192	100.0

For a reason people do not reuse plastic bags, most of the respondents (76.7%) stated that this is because the plastic bags have become dirty after using them. It is difficult to avoid the dirtiness of plastic bags after using them. Therefore, we should try to reduce the use of plastic bags instead of trying to reuse them.

Table 5 shows that "no market for buying plastic bags" accounted for 86.8%, followed by the cheap price of plastic bags, 8.4%. Presently, plastic bags are ignored for recycling in Cambodia. It is estimated that 100 small plastic bags cost only 10-15 cents. Separating and collecting the plastic bags are a significantly high cost compared to their very cheap price [26]**.** The main reason plastic bags do not have a market may be because there is no plastic bag recycling company. Plastic bags are mixed with other types of waste in Cambodia. Therefore, the cost of cleaning and separating the plastic bags could be a major challenge for a company**.**

Table 5. Reasons for not collecting plastic bags to sell

Reasons for not collecting plastic bags to sell	Responses	
	N	Percent
There is no intermediary/waste shop buying plastic bags	145	86.8
The price is very cheap	14	8.4
I do not have time to collect the plastic bags	3	1.8
There are too few plastic bags to sell	5	3
Total:	167	100.0

People are able to find a method to separate or reuse waste if the waste has value [26]. Thus, people will try to segregate and collect the plastic bags to sell them if the plastic bags have a market with a good price, compared to other plastics. However, this needs strong support and good collaboration from the government, local authorities, companies, and citizens to implement this action successfully.

Related to the current practice of how local people deal with plastic bag waste, the result showed that a majority of people disposed of plastic bags with another type of solid waste after using them, which accounted for 93.7 %. This is a common practice in developing countries. This is also similar to some studies in India, Botswana, and Pakistan where plastic bags were in open dumps, accounting for 62%, 45%, and 35.5%, respectively [30, 32, 33]. One way to encourage people to separate plastic bags is promoting long-term education for the people. Moreover, education alone is not enough. There is a need for collaboration among local people, solid waste collection services, and local authorities.

3.3 Proposed policies for plastic bag management

Several countries have implemented different policies in plastic bag management, including a ban on plastic bag use and a fee or tax on a plastic bag.

- Several countries have banned plastic bags nationwide, including Bangladesh, Bhutan, Cameroon, Kenya, and Italy.
- Some countries have a localized ban on plastic bags, including Pakistan, Philippines, Maldives, Australia, Belgium, and Brazil,
- Various countries ban the importation, distribution, and use of lightweight plastic bags: Sri Lanka, Senegal Estonia, and Colombia.
- Moreover, many countries impose a tax or charge a fee for plastic bags: Hong Kong, Israel, South Africa, Czech Republic, Denmark, Germany, Netherlands, Sweden, United Kingdom (England, Northern Ireland, Scotland, Wales) [27-29].

Regarding the banning of plastic bags, only a few countries could have successfully implemented this policy because of their strong enforcement. Several countries have failed to implement a policy due to a lack of serious enforcement. Moreover, some countries have a moderate result in local areas

Related to a tax or a fee for a plastic bag, the result shows that several countries have successfully implemented a policy with the reduction of a large number of plastic bags and an increase in tax revenue.

The proposed policy options for plastic bag management are shown in Fig. 4. People chose an alternative product, which accounted for 43.2%, as their first option in proposing a policy for plastic bag management. These alternative products are plant leaves, paper, and others for 40.2%, 35.2%, and 24% respectively. Moreover, people also prefer to introduce a fee for plastic bags (28.6%) followed by banning plastic bags (28.2%).

Therefore, a fee and providing an alternative material are the suggested options for plastic bag waste management. The designed alternative products need a satisfactory supply and acceptable price. The alternative products have to be viable, visible, accessible, and affordable. As a result, they could challenge the established convenience of plastic bags [26]. The implementation of a charge the plastic bag fee policy should extend to the main source of plastic bag consumption, especially the agricultural markets and street retailers [34]. A fee can be established at supermarkets, markets, and grocery stores.

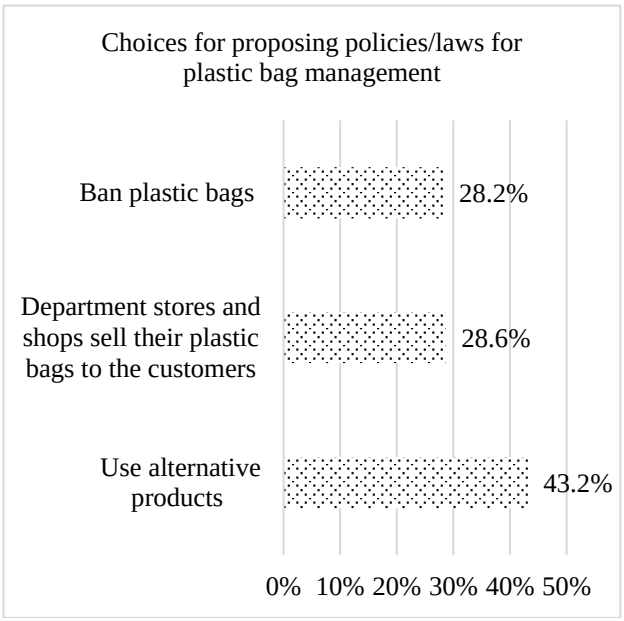

Fig. 4. Choices for proposing policies/laws for plastic bag management

4. CONCLUSION

With the current situation in Cambodia, banning plastic bags should not be implemented because of the weakness of law enforcement, limited education of the people, and the lack of availability of alternative materials which could be used for plastic bags. The recommended policy options for plastic bag management in Cambodia are: charging a fee for a plastic bag, promoting alternative materials, and providing awareness raising and education programs to the local people.

Actually, charging a fee for plastic bags has already been implemented in a few major supermarkets in Cambodia since 2018. Moreover, implementing a fee policy should be pursued for the sources which have generated a lot of plastic bags, such as traditional markets, minimarts, grocery shops, commercial shops, food shops, and retailers.

In addition, promoting alternatives to plastic bags should be encouraged for consumption, production, and investment. Promoting alternative materials should be carefully considered for the price, quality, and quantity. These should not be much different from the current situation of using plastic bags.

Furthermore, providing awareness raising and education programs let people be aware of the negative

effects of plastic bags. This encourages them to reduce plastic bag consumption as much as possible. Awareness raising programs can be any activities, such as environmental campaigns, outreach activities, workshops, meetings, pilot projects, social media, television, radio, posters, and school curricula.

These proposed policies can be implemented effectively for reducing plastic bags. The policies need good strategies, efforts, and the support of all stakeholders, including governmental institutions, non-governmental organizations, private sectors, and local people with short and long-term plans and enforcement.

Further research on plastic bags, especially the study of the behavior of people for plastic bag consumption is crucial and needed urgently in Phnom Penh and other cities in Cambodia.

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