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Appropriate Option of Market Solid Waste Management based on the Stakeholder Perspectives: A Case Study in a Central Market of Agriculture Products, Thailand

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Abstract

The objective of this research was to develop the appropriate option of solid waste management for a central market of agriculture products in Thailand based on the stakeholder perspectives. The cross-sectional descriptive study was employed to investigate the current situation of solid waste management in the market, to examine factors influencing solid waste management behavior among the merchants, and in-depth interviews of key persons of the market with an attempt to develop and propose the appropriate solid waste management option. The results revealed that sex (AOR: 1.75; 95%CI: 1.09-2.82), education (AOR: 1.75; 95%CI: 1.01-3.03), knowledge of solid waste management (AOR: 1.76; 95%CI: 1.02-3.03), attitude toward solid waste management (AOR: 2.88; 95%CI: 1.03-8.03) and accessibility to solid waste management (AOR: 1.97; 95%CI:0. 004-1.240) were found to be the significant predictors of solid waste management behavior. Concerning the in-depth interviews on current solid waste management among key persons, it was found that a knowledge and information project is needed to educate the merchants and customers, and that the interesting announcements might help people to understand more and have better behavior. Therefore, the preferred options of solid waste management were verified by the focus group technique with the stakeholders. The results showed that the solid waste management education and information campaign with solid waste management equipment provided option was selected for the Central Agricultural Products Market, Thailand to be launched in this market.

1. Introduction

During this era of rapid population growth, urbanization and economic development in developing countries, the consumption rate has also increased, which consequently leads to the generation of a dramatically raised volume of solid waste. It is a significant challenge to deal with this [1]. Accumulated solid waste may result in dirtiness and environmental nuisances including odors, flies, and blowing litter that directly causes an aesthetic problem. In the long-term effects, solid waste can also contaminate the environment by solid waste disposal that transfers harmful substances to the air, water and soil, which may destroy the environment and pose human health and safety problems. The sites of solid waste are the places where insects and small rodents feed or nest and in this way, these vectors can carry out pathogens that are found in solid waste to human habitats [2]. This may cause infectious diseases in humans such as diarrhea, tetanus, eye infection and other illnesses. In addition, solid waste also poses a negative impact on economics and resources from the cost of disposal. Hence, due to these effects, solid waste management has received much attention [2, 3].

Thailand, one of the developing countries in Asia, has been facing serious solid waste management problems for a long time. The Pollution Control Department in Thailand [4] reported that the amount of solid waste in 2010 was generated from all over the country, Bangkok and the local administrative organization about 15.16 million tons, or 41,532 tons/day. In 2012, solid waste was generated at a rate of approximately 24.73 million tons, or 67,577 tons per day. The volume of solid waste generated has increased 35.38 % from 2011 [5]. From this figure, it can be seen that Thailand has been rapidly creating an increasing amount of solid waste every year.

Markets are the one of main sources of solid waste generation, and contribute about 20 % of total solid waste generation. Thus, they are the second largest solid waste generator after households [2]. According to the Central Agricultural Products Market report, it was stated that approximately 120 tons of solid waste are being generated every day. During 2014, the total amount of solid waste generation was 44,730 tons, which was a slight increase from 2013 of about 4.7%. The composition of solid waste generation was mostly organic waste (76.2%) and the rest is made up of plastic, food waste, paper, glass, metal, and wood. At the present time, the Central Agricultural Products Market, Thailand has to deal with the increasing rate of solid waste generation and the diversity of types of solid waste. Particularly, when the seasonal changes occur between May to June in every year, it impacts solid waste generation by having the effect of producing large amounts of solid waste, especially organic waste such as seasonal fruits in this period. For this reason, the Central Agricultural Products Market, Thailand pays more for solid waste disposal especially during May to June than at other times of the year.

The main purposes of solid waste management strategies are to address the health, environmental, aesthetic, land-use, and resource issues [6], and to support employment generation and especially economic productivity [7]. Sukholthaman and Sharp [8] mentioned that a great deal of research in recent years has evolved to adopt decision support tools to design management systems. Optimization models have widely been used as supporting tools offering for selecting the best systems. Various research studies reported that the key success policy and approach of solid waste management was the participation from the communities [9-12] and stakeholder involvement [13,14] in the designed schemes. Moreover, knowing the factors that affect the behaviors toward solid waste management can apply to an effective and sustainable program in the long term [15]. A number of previous reports investigated the solid waste management behavior by indentifying for participant's demographic variables that are the general predictors and the general frame of solid waste management model [15-17]. Hence, the appropriate option of solid waste management is an important, necessary and helpful system for the Central Agricultural Products Market, Thailand to solve this problem based on the stakeholder perspectives.

However, a lack of research in terms of developing the option of solid waste management in the Central Agricultural Products Market, Thailand was discovered. From this situation, the current solid waste management, quantity and characteristics of solid waste generation and solid waste separation and the factors that influence solid waste management behavior among the merchants in the Central Agricultural Products Market, Thailand were studied in order to develop and apply the appropriate solid waste management option for this market based on the views of the stakeholders.

2. Materials and methods

2.1 Case study background
This study was undertaken in the Central Agricultural Products Market, Thailand. It is located in PathumThani province, which is about forty kilometers from Bangkok, Thailand. It is one of the largest wholesale agricultural products markets in Southeast Asia, and a trading point for farmers, sellers and buyers of the large quantities of both locally produced and imported food products. There are more than 50,000 customers daily and approximately 12,000 metric tons of products are traded daily. The primary product categories traded at this market were fruits, vegetables, meat and fish, rice and crops, flowers, pet supplies, and plants.

2.2 Study framework
The flow chart of developing the solid waste management option is shown in Figure 1. Firstly, field observation and secondary data from annual report from 2006 to 2014 were used to gather further information in terms of the current solid waste management data in this market including current solid waste management, quantity and characteristic of solid waste generation and solid waste separation. Secondly, solid waste management behavior among merchants in this market regarding knowledge, attitudes, accessibility and the level of solid waste management behavior were assessed by a well-structured questionnaire. In addition, the opinions towards the current solid waste management in this market were surveyed by the in-depth interviews with key persons. Thirdly, option development of solid waste management for the Central Agricultural Products Market was developed from the results of the questionnaire and in-depth interviews. The appropriate option of solid waste management was validated and determined by conducting focus group interviews with groups of merchants and key persons of the market and the market consumers. This research was approved by the ethics committee of Mahidol University Institutional Review Board (COA No. MU-IRB 2015/122.3103).

2.3 Participants and sampling procedure

Concerning the stakeholder perspectives, the participant subjects in this study consisted of two groups, including merchants and key persons of the market. However, the consumer perspectives of this market were also concerned and involved in the part of option verification by a focus group technique. Firstly, 1,937 merchants in the market were the target population of this study.
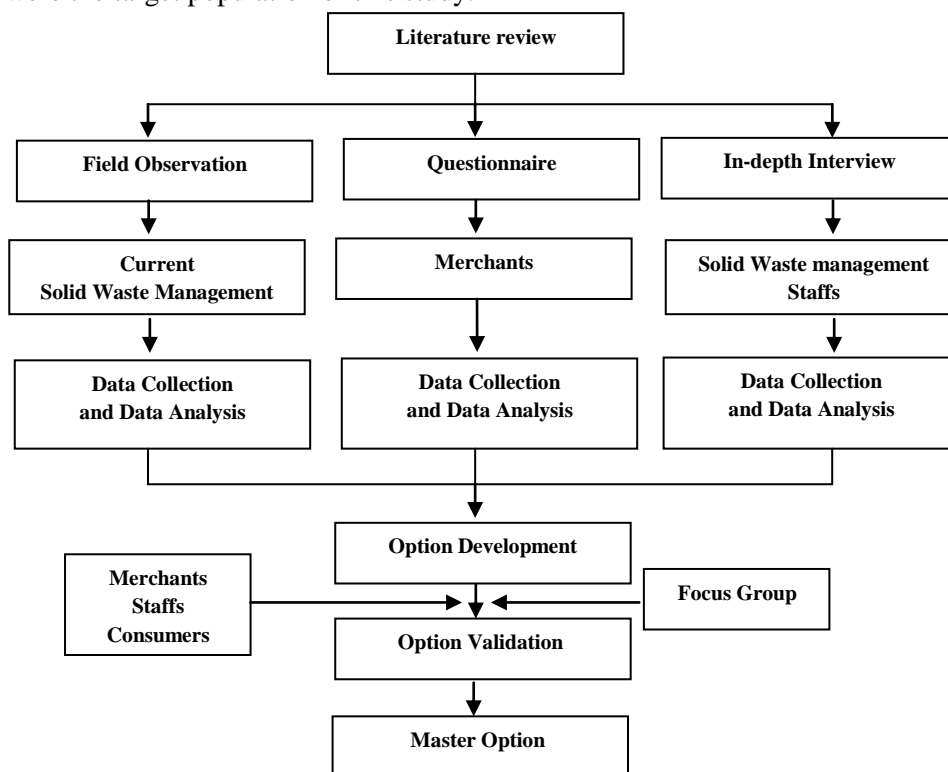

Figure 1: Flow chart of developing solid waste management option

The sample size was analyzed by a confidence interval of 95 %, an acceptance error of 5 %, and a proportion of low preventive behavior of 0.5. According to this method, a total of 355 participants were recommended. Only shop owners or stall owners who had been selling products in this market for at least one year (participants should be understanding and authorizing with the solid waste management of this market for a while.) were invited to complete the questionnaire, and 350 agreed to fill in the questionnaire. A cluster sampling method was used to select six types of products from the market (shown in Figure 2). Then, a probability proportional to size sampling method was performed to calculate the number of samples from each type of product. As a result, there were 140, 81, 24, 24, 13 and 73 merchants from the fruit market, vegetable market, plant market, dry crops and rice market and other markets, respectively. Based on these results, simple random sampling was used to include the participants in this research. Secondly, three offices and three subcontractors of representative staff for at least 1 year work in this market were contacted in order to gather further information about the opinions of the officers and subcontractors toward the current solid waste management in the market by in-depth interviews. Thirdly, the appropriate option of solid waste management based on the stakeholder perspectives was validated by three persons of each market type (18 persons) with six persons of the representative staff and consumers for at least 1 year work in this market.

2.4 Data collection tools

The data collection tools in this study consisted of three questionnaires. The first questionnaire was designed to collect the data from merchants and included five parts. Part I was the socio-demographic factors consisting of the background of the merchants in the market. Parts II and III were about the knowledge of and attitude toward solid waste management, respectively, including (1) solid waste generation, (2) solid waste handling and separation, storage, and processing at the source, (3) solid waste collection, (4) solid waste transfer and transport and (5) solid waste disposal. Part IV was on the accessibility of solid waste management information and consisted of six questions about the accessibility of merchants to solid waste management information. Part V was on solid waste management behaviour and consisted of 20 questions about appropriate methods of solid waste management. Higher than 80 % of total scores was used to category the high level of knowledge, high

level of attitude and good behaviour toward solid waste management. Reliability tests for the parts on knowledge, altitude and behaviour were 0.70 of the Split-Half Method of Spearman- Brown's collection, 0.70 of Conbrach's Coefficient-Alpha formula and 0.70 of Conbrach's Coefficient-Alpha formula, respectively. The second questionnaire for the in-depth interview technique was designed to collect the opinions of respondents according to current solid waste management in the market and included four questions. This questionnaire was verified by experts for accuracy, which covered the content validity. The last questionnaire of the focus group technique was designed to collect the opinions of respondents according to the option development of solid waste management in the market with five guiding questions. This questionnaire was verified by experts for accuracy, which covered the content validity.
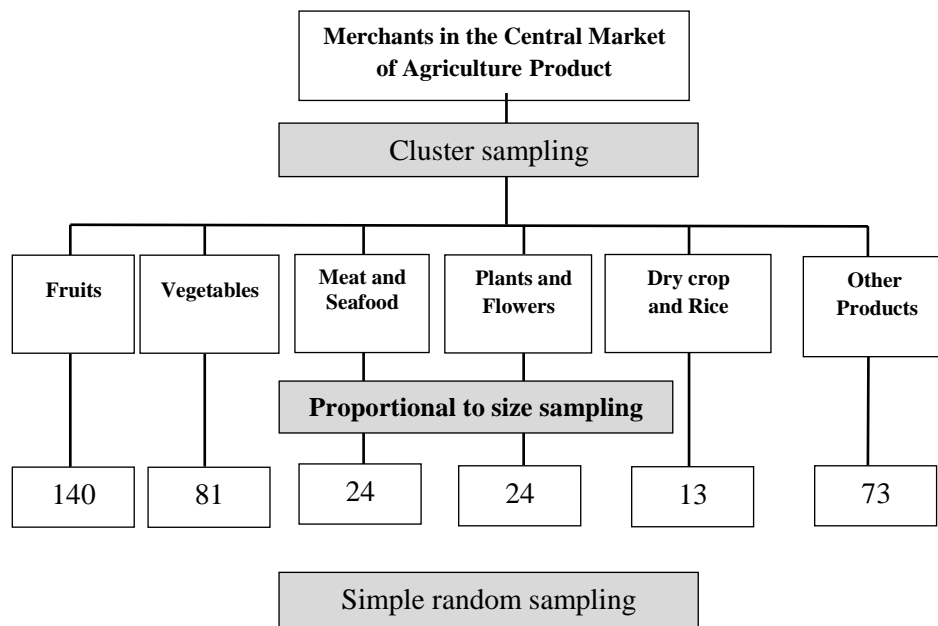

Figure 2: Procedure of sampling

2.5 Statistical analyses
Statistical analysis was performed using SPSS software. The knowledge, attitudes, accessibility and solid waste management behaviour of the study participants were analyzed by using descriptive statistics. According to the quantitative variables in this study, they were shown as mean ± standard deviation. Various researches [8,15] indentified that the chi-square analysis and logistic regression analysis was used to investigated the relationships between factor affecting on the solid waste management behavior. Hence, Chi-square and logistic regression were used to determine the association and measure the strength of the relationships between factors. Multiple logistic regression was performed to identify how the elements in a direction of variables respond to changes in others and to find the predictive factors of the dependent variables. The independent variables in this research were socio-demographic characteristic, knowledge, attitude and accessibility of solid waste management and dependent variable was solid waste management behavior. In additional, field observation, in depth interview and focus group were analyzed by using descriptive method and content analysis.

3. Results and discussion

3.1 Current solid waste management in the Central Agricultural Products Market, Thailand
According to reports of the case study market from 2006 to 2014, it was revealed that the Central Agricultural Products Market generated solid waste of approximately 120 tons per day and 44,000 tons per year. Particularly, in the seasonal period during May to June, the amount of solid waste can increase to 150 tons per day. Solid waste in this market can be classified into nine groups; organic waste, plastic, food waste, wood, paper, glass, clothes, metal, and miscellaneous. The results from sampling and analysis of the composition and mass in 2014 showed that the solid waste composition was dominated by organic waste (75%) and plastic (15%), while another 10% included paper, glass, woods, clothes, metal and miscellaneous.

The process of solid waste management in this market can be categorized into four steps (Figure 3). The first step is solid waste collection and separation including the primary collection, in which solid waste workers collect solid waste from each of the garbage bins in every shop and stall and carry it to be collected in the nearest garbage container. Then, in the secondary collection, solid waste workers collect solid waste from each garbage container and transfer it to a storage place.

For the third step, the solid waste transfer and transportation, after the storage containers are filled, the garbage trucks collect the solid waste from each storage container and transfer it directly by collection vehicle to store at a storage area, which is the final destination of the solid waste in this market.

The last step of the solid waste management is solid waste disposal, which is not under the responsibility of this market. Solid waste is transported from the storage area by another organization and is then dumped into another area.
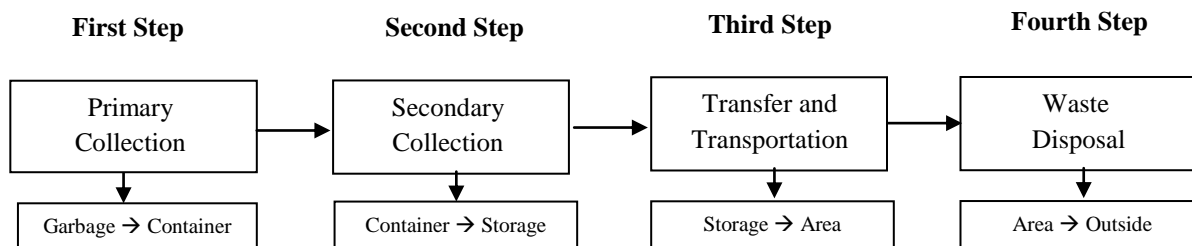

Figure 3: The process of solid waste management in this market

3.2 Merchant perspective: knowledge, attitude, accessibility and behaviour of solid waste management
According to the questionnaires, most of participants (61.4 %) were female and 38.6 % were male. Very nearly half of them, or 49.10 %, were in the age group of 32 – 48 years old. Based on the participants' backgrounds, some of them (26 %) were educated in secondary school and university. A proportion of 59.1% out of the total had a monthly income of less than 50,000 baht. Most of the participants (59.7 %) had been selling products in this market for less than 10 years. The results also revealed that 39.7 % of participants were selling fruits.

In accordance with the criteria for standard procedures, the results revealed that more than half (56.9 %) of the participants had a high level of knowledge of solid waste management. Most of the participants (52 %) also had a high level of positive attitude. Table 1 presents the results of the chi-square analysis, logistic regression analysis, and multiple logistic regressions covering the relationships between independent variables and dependent variables. The results of this survey revealed that a significant association was found between sex and solid waste management behavior (AOR: 1.748; 95 % CI: 1.086 – 2.815). This indicated that male merchants were almost two times more likely to have poor solid waste management behavior. This finding is in agreement with results obtained by many previous studies, which mentioned that women had demonstrated a higher satisfactory solid waste management behavior than men [18-23] because the main responsibility of male merchants is to transfer and arrange their products. As a result, they are not willing to participate in any solid waste management behavior. Another reason could be that because in daily life, female merchants are also housewives that may come into contact with solid waste, so they might be more willing to manage solid waste properly. According to some previous studies, the results also indicated that the success factor for community participation in solid waste management was the role of females [6].

The educational level of the merchants affects the solid waste generation, which can decrease or increase the generation rate of solid waste. In this study, it was also found that the association between education level and solid waste management behavior was significant (AOR: 1.746; 95 % CI: 1.008 – 3.025). The result was stated that the merchants who had been educated in secondary and above were almost two times more likely to have poor solid waste management behavior. Merchants who had been educated in higher than primary school might have been educated about appropriate solid waste management behavior in school. In addition, previous studies indicated that educational level might influence the solid waste separation and recycling behavior [24].

Furthermore, the analysis in Table 1 shows the significant association between knowledge and solid waste management behavior (AOR: 1.758; 95 % CI: 1.019 – 3.033). It was clear that merchants who had a low level of solid waste management knowledge were almost three times more likely to commit poor solid waste management behavior. A study done in Malaysia indicated that knowledge is an important factor to predict solid waste separation behavior [25]. Previous research studies that were conducted on the knowledge of recycling found that level of knowledge can predict the recycling behavior of the respondents [26, 27]. Another study found that recyclers have significantly more knowledge about solid waste recycling than non-recyclers [28]. It

was also found that there was an association between attitudes of solid waste management and good solid waste management behavior (AOR: 2.881; 95 % CI: 1.033 – 8.033). The merchants who had poor attitude levels toward solid waste management were three times more likely to have poor behavior in solid waste management. Attitude toward solid waste management was the strongest factor to predict separation behavior and recycling behavior [29]. In terms of recycling behavior, attitude towards solid waste recycling was important to explain households' propensity to participate in recycling. In addition, attitudes had the strongest positive effect on recycling participation [30]. Merchants with good attitudes about solid waste management are concerned about the accumulation of solid waste near their living area, which might affect their health, sanitation, safety, and also the environment. The merchants consider the impact of the increasing of the solid waste generation rate. They intend to reduce the amount of waste that they generate in each day, and they will separate solid waste for reusing or recycling in order to decrease the amount of solid waste for disposal. Moreover, as a result, merchants may feel good about recycling and feel bad if they do not participate in solid waste recycling activities. A Malaysian study done revealed that attitude toward waste management is the strongest factor that is related to waste management behaviors [31].

In terms of accessibility to solid waste management information, the association between accessibility and solid waste management behavior was found to be significant (AOR: 1.873; 95 % CI: 1.201 – 2.922). It revealed that merchants who had not received information about solid waste management were almost two times more likely to have poor solid waste management behavior, which means that the merchants who are better informed about solid waste management information likely have better solid waste management behavior. The reason could also be because merchants who are regularly informed about appropriate solid waste management may understand the way to minimize the solid waste generation rate and the ways to separate solid waste into recyclable and non-recyclable items to reuse or recycle solid waste again. Regularly provided information is an important factor that can give the information to the merchants, and better information might increase the participation in solid waste management. With regard to the sources of information, a survey study done in the United States mentioned that most recyclers are more likely to have one or more sources of information, for example friends, newspapers and television. Various sources of recycling knowledge coming from public education and information through public campaigns expectedly show a positive correlation with recycling rates [32]. According to several previous studies, in terms of solid waste separation behavior, a study found that better information can make separation and recycling behavior easier [5,30, 33-35]

3.3 Key person perspective of the market: in-depth interviews on current solid waste management

In-depth interviews were conducted in this study to interview the solid waste management officers and sub-contractors regarding solid waste management problems and recommendations on solid waste management. The results showed that the Central Agricultural Products Market officers who work in the solid waste management department mentioned that solid waste management in the market is still not efficient in terms of solid waste disposal. However, although they cannot transform the organic waste to make useful products, they can still handle the collection of a large amount of solid waste well, as they can collect the solid waste from the market area properly and provide coverage to all areas in the market. Moreover, the officers indicated that the most significant problem about solid waste management is the merchants' participation. Most of the merchants and customers do not separate solid waste and they also throw waste onto the ground. They are not concerned about how to manage the waste properly. Hence, the officers recommended that the market should launch the knowledge and information project that can distribute the information and knowledge about appropriate solid waste management behaviour to the merchants. Also, sometimes an incentive is needed to encourage the merchants and customers to participate in proper solid waste management.

In addition, the sub-contractors of this market also mentioned that people's participation is the most important factor to achieve the successful solid waste management. The sub-contractors recommended that a knowledge and information project is needed to educate the merchants and the customers. The interesting announcements might help people to understand more and have better behaviour.

3.4 Stakeholder perspectives: options development of solid waste management by a focus group technique

Proposed solid waste management options for the Central Agricultural Products Market, Thailand were designed to minimize the initial generation of solid waste through source reduction, then through reuse and recycle to further reduce the volume of material being sent to dispose of at landfills or being disposed of by other alternatives. Options development of solid waste management for the market is focused on (1) solid waste generation, (2) solid waste handling and separation and storage, and (3) solid waste collection. Different proposed solid waste management models are as follows:

Table 1: The association between socio-demographic factors with solid waste management. (Chi-square analysis and logistic regression analysis)

Socio-demographic factors	Poor Behaviour		Good Behaviour		Crude OR	95% CI	p-value
	n	%	n	%			
Sex							
Male	95	43.40 %	40	30.50 %	1.743	1.103 – 2.755	0.02*
Female	124	56.60 %	91	69.50 %	1		
Age (year)							
≤ 48	168	76.70 %	92	70.20 %	1.396	0.857 – 2.276	0.18
> 48	51	23.30 %	39	29.80 %	1		
Education level							
Primary school	64	29.20 %	26	19.80 %	1.667	0.993 – 2.801	0.05*
Secondary and above	155	70.80 %	105	80.20 %	1		
Monthly income (baht)							
<50,000	97	44.30 %	65	49.60 %	1.24	0.803- 1.912	0.33
≥ 50,000	122	55.70 %	66	50.40 %	1		
Duration of commerce							
< 15	80	36.50 %	38	29.00 %	1.041	0.650–1.669	0.87
≥ 15	139	63.50 %	93	71.00 %	1		

*p-value < 0.05

Table 1: The association between socio-demographic factors with solid waste management. (Chi-square analysis and logistic regression analysis)(cont.)

Socio-demographic factors	Poor Behaviour		Good Behaviour		Crude OR	95% CI	p-value
	n	%	n	%			
Type of product							
Fruit	94	67.60 %	45	32.40 %	1		
Vegetable	53	65.40 %	28	34.60 %	0.906	0.508-1.618	
Meat and seafood	10	43.50 %	13	56.50 %	0.368	0.150-0.904	
Flower and plant	12	52.20 %	11	53.80 %	0.522	0.214-1.274	
Rice and dry crop	7	53.80 %	6	46.20 %	0.559	0.177-1.758	
Others	43	60.60 %	28	39.40 %	0.735	0.406-1.331	0.22
Knowledge of solid waste management							
Low	31	14.20 %	6	4.60 %	3.435	1.393 – 8.474	0.007*
High	188	85.80 %	125	95.40 %	1		
Attitude of solid waste management							
Low	23	10.50 %	5	3.80 %	2.957	1.096 - 7.980	0.032*
High	196	89.50 %	126	96.20 %	1		
Accessibility to solid waste management information							
Yes	71	32.40 %	62	47.30 %	1		
No	148	67.60 %	69	52.70 %	1.873	1.201 – 2.922	0.006*

*p-value < 0.05

3.4.1 First option: <u>Solid waste management education and information Project</u>

According to the findings of this study, it was indicated that knowledge was one of predictors of solid waste management behavior among the merchants in the market, so an educational project will be launched to educate the merchants to become more familiar with the process of appropriate solid waste management, and also to increase their participation in the solid waste management.

The educational and information project aims to increase merchant's knowledge about proper solid waste management behavior (shown in Figure 4). The details of the educational and information project should promote solid waste reduction, and reusing and recycling behavior without monetary motivation. A project of education and information is necessary to the changing of merchant attitudes [17] and can also encourage non-participating households to begin and participating households to increase their behavior. The market should take on the facilitator's role of providing knowledge of solid waste management via an educational and information project.

In order to successfully increase participation in proper solid waste management, merchants should be educated about appropriate handling of solid wastes that are generated, especially the solid waste reduction, separation, reuse and recycling. This Solid Waste Management Education Model should be conducted in order to disseminate information to merchants and also to promote the public participation.

3.4 2.Second option: <u>Improving solid waste management equipment</u>

Uncontrolled solid waste accumulation poses the environmental problems and serious health risks. Implementation of a solid waste management system is essential to deal with the solid waste generation as economically and safely as possible. It is important that waste is collected from all sources as efficiently as possible, and disposed of in controlled disposal facilities (Figure 5).

As the facilitators for the solid waste management system project, the market should provide the appropriate equipment for the merchants. The factors that must be considered in the onsite storage of solid waste include:

(1) The types of container to be used

- Size of container at each stall and store can be a small plastic container that can contain approximately 30 – 40 litters, which is suitable for small isolated commercial establishments that generate low-volume solid waste.

- Solid waste should be stored separately in three types of garbage bins, which will separately store solid waste of each type. Green garbage bins should be used to store organic waste, yellow garbage bins should be used to stored saleable waste and blue garbage bins should be used to stored general waste.

(2) The container location

- Green and blue garbage bins should be located at each stall and shop. Yellow garbage bins could be located near every block of the commercial zone.

- Labelling of the garbage bins is important to identify the type of appropriate solid waste.

3.4.3 Third option: <u>Solid waste management education and information with improvement of solid waste management equipment</u>

This option was designed with the purpose to minimize the initial generation of solid waste through source reduction, then through reuse and recycling to further reduce the volume of material being sent to dispose of at landfills or being disposed of by other alternatives. It is focused on three steps, which include solid waste generation, solid waste handling, separation and storage, and solid waste collection.

In this context, it is integrated between the educational program and the providing of appropriate solid waste management equipment. In accordance with the educational program, it aims to increase the awareness of merchants by educating them in terms of proper solid waste management (Figure 6). The details in the educational and information project should promote solid waste reduction and reuse and recycling behavior, and also encourage non-participating merchants to begin to participate in appropriate solid waste management behaviour. As the facilitators for the solid waste management system project, the market should provide the appropriate equipment for the merchants. The factors that must be considered in the onsite storage of solid waste are included in Figure 5, which shows a flowchart for the processing of solid waste management options. Finally, the solid waste management education and information with solid waste management equipment provided option was selected by the Central Agricultural Products Market, Thailand to implement in this market by the focus group with the stakeholder perspectives.

3.5 Recommendation for further study and limitation of this study

The finding of this study should be recommend for further study with the option implementation, monitoring and evaluation process in this market. Moreover, the advanced techniques such as life cycle analysis and costing, material flow analysis, and participatory research can be apply to integrate in the development process

of solid waste management options. Besides, the secondary data of solid waste generation and composition from this market is the major concern and limitation of this study.
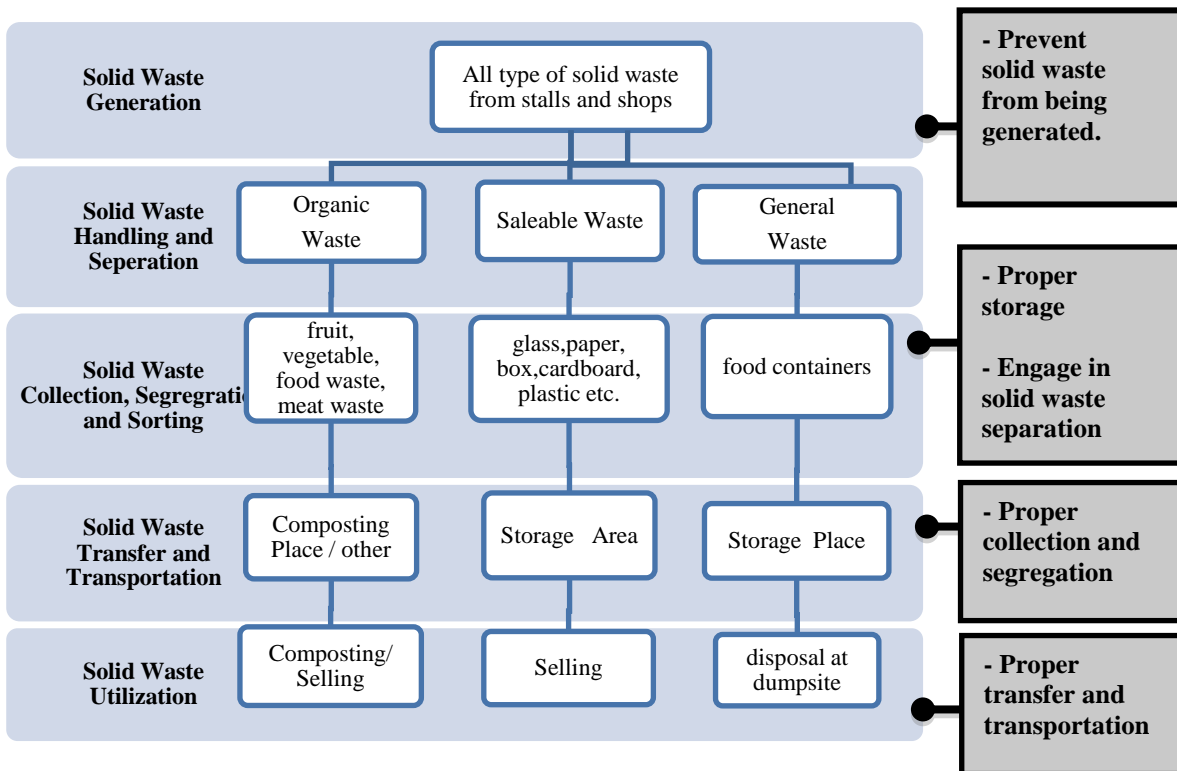

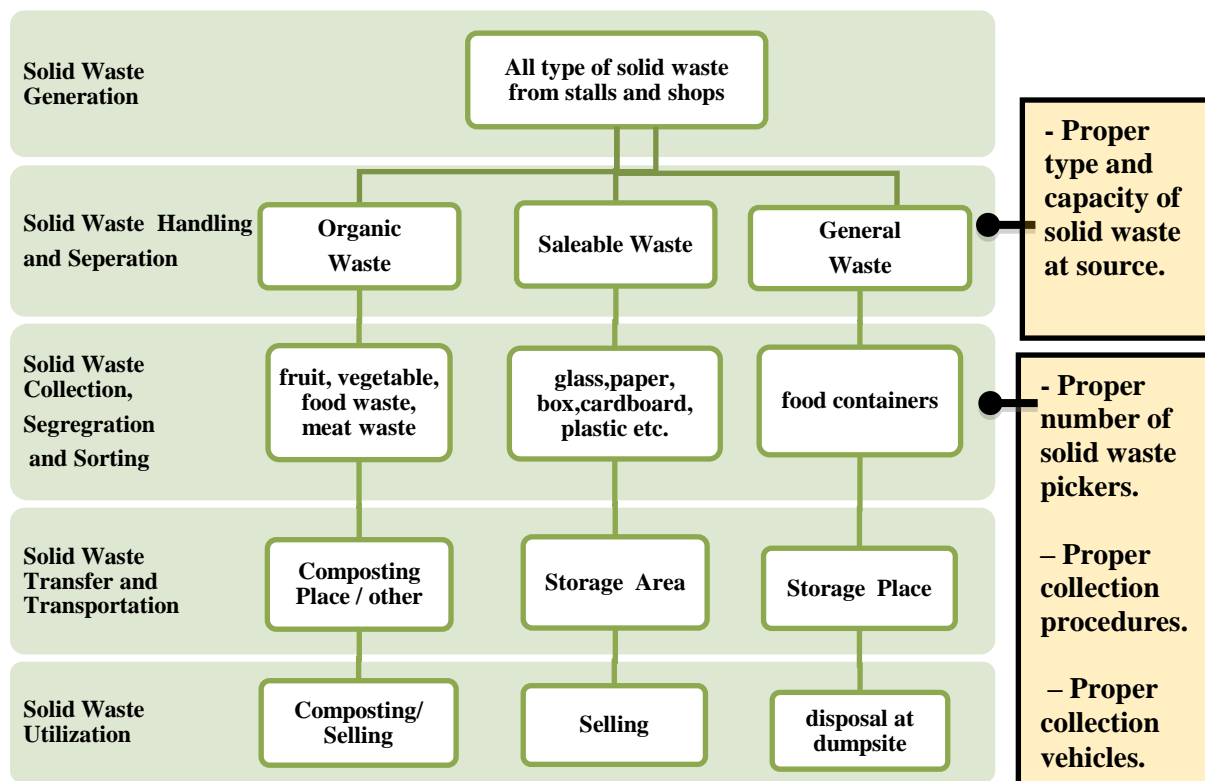**Figure 4:** Solid Waste Management Education and Information option

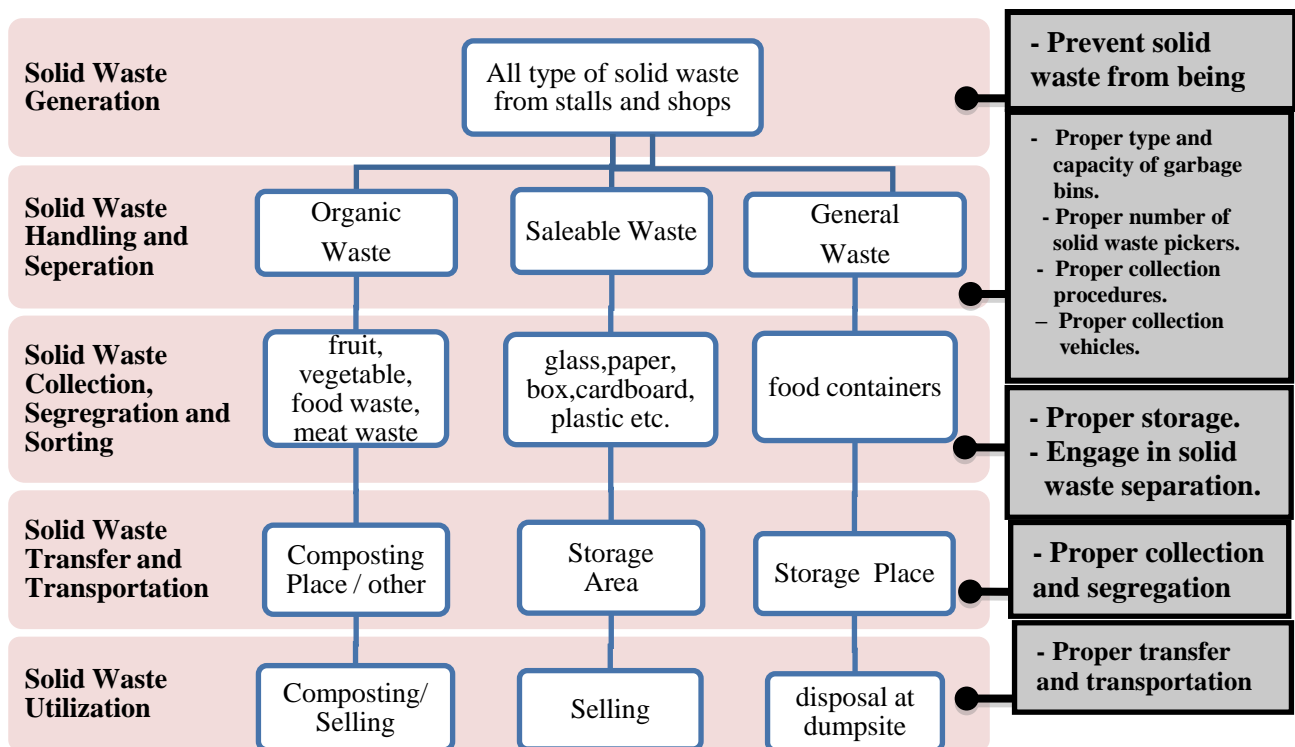**Figure 5:** Solid Waste Management Equipment Supportive option

Figure 6: Solid waste management education and information with improving of solid waste management equipment

Conclusion

This study presents the appropriate option of solid waste management for a central market of agriculture products in Thailand based on the stakeholder perspectives. According to results in this study, it was indicated that sex, education, knowledge of solid waste management, attitude toward solid waste management and accessibility to solid waste management information are predictive factors of solid waste management behavior. Therefore; these variables must also be considered as involved in the proposed solid waste management behavior. Besides, a knowledge and information project is needed to educate the merchants and customers, and that the interesting announcements might help people to understand more and have better behavior from in-depth interviews on current solid waste management among key persons. Moreover, the solid waste management education and information with solid waste management equipment provided model was selected by the Central Market of agriculture products.

Acknowledgements

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