

**REPORT ON**  
**CONSUMER INFORMATION**  
**FOR SUSTAINABLE CONSUMPTION AND PRODUCTION**  
**IN FOOD SUPPLY CHAIN IN BANGKOK**



**Submit to United Nations Environment Program (Thailand)**

**Prepared by Thailand Environment Institute**

**September 2021**

**CONSUMER INFORMATION**  
**FOR SUSTAINABLE CONSUMPTION AND PRODUCTION**  
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# CONSUMER INFORMATION FOR SUSTAINABLE CONSUMPTION AND PRODUCTION IN FOOD SUPPLY CHAIN IN BANGKOK

Sustainable Development Goals (SDGs) Goal 12 - Ensuring sustainable production and consumption patterns which was announced by the United Nations in 2015. The third target under this goal (Target 12.3) calls for cutting in half per capita global food waste at the retail and consumer level, and reducing food losses along production and supply chains (including post-harvest losses) by 2030, and to enable member States to reduce food loss and food waste through systematic management. It has a Global Food Loss Index for measuring losses over a range of agricultural production from post-harvest to retail and the per capita food waste (kg/year) index, which measures food waste in the range from retail to consumption.

As the most of the food waste is a problem for urban society, which is a society of consumption rather than production. There is little space which is a barrier to disposing of food waste. The complexity of such society and infrastructure poses a challenge in managing food waste in metropolitan areas around the world. Therefore, this study which conducted based on the Global initiative on Green Technology on Food Waste launched in 2020 to the large urban contexts. Bangkok Thailand is selected as one of five studies area for appropriate use of technology with an intention that the experiences and lessons of the study can be applied to other urban areas.

## 1. OVERVIEW

*This section on the food supply chain in Bangkok indicate situation analysis, identification of drivers or root causes, and provision of information on stakeholders, existing policies and measures, and lessons learnt. It also presents a stakeholder mapping and local policy analysis.*

### 1.1 General Information of Bangkok

Bangkok is the capital of Thailand, governed by a special local government, occupying about 1,568 square kilometers and covering large areas. It therefore, was divided into 50 districts in order to expand administrative services throughout all areas which Bangkok Metropolitan Administration (BMA) is actively responsible for.

At the end of 2020, the registered Bangkok population is about 5.59 million people. Regarding the non-registered it was presented by Department of City Planning, BMA research found it was not less than 5 million people. Therefore, total number of Bangkok population is about 10.59 million people, with the population density of 6,754 people per square kilometer. Land use in Bangkok is dense in the center of Bangkok and expanding around. There is a limited cultivated area, which remains as a rice fields, vegetable plots, ornamental flowers, etc. Therefore, it cannot support for Bangkok people consumption. Consequently, Bangkok people are relying on food from other sources outside the area.

The food supply chain in Bangkok mobilized through wholesale and retail mechanism which has the food entrepreneurs scattered throughout the area. While there are about 60 large retail-wholesale in

Bangkok and spread in neighboring provinces distribute along the main roads that leave Bangkok to other provinces and regions.

The case of modern trade in Bangkok with a large number of branches, including Top Supermarket, Macro, Lotus, 7-eleven, which has grown from sales of both fresh food and dry food. They have developed infrastructure to support the development of business practices lifestyle and provide customers with convenient access to products as well as growing from ready-to-eat and chilled products with a tendency to increase in number and be able to grow well from consumer behavior that likes convenience. While the trend of expanding branches of large retailers such as hypermarkets has begun to slow down and turned to focus on expanding small branches near communities to reach more target customers, such as Max Value and Villa Market. But there are customers in the group of consumers with high purchasing power, focusing on building a good image and select high quality products for sale. Currently, most of wholesales and retrials have being adapting an online service to meet the needs of customers.

Fresh market is another form of food distribution sources that is important for Bangkok people. In general, the fresh market is regulated by many agencies. Currently, there are approximately 485 markets, 95 percent of which are privately owned markets, and 2.5 percent are market offices, BMA, the rest is the market of other agencies. The various markets are supervised by the Department of Health, Department of Internal Trade, and Market Organization, Mistry of Interior. These organizations promote a good hygiene and environment for the markets but no food waste management criteria.

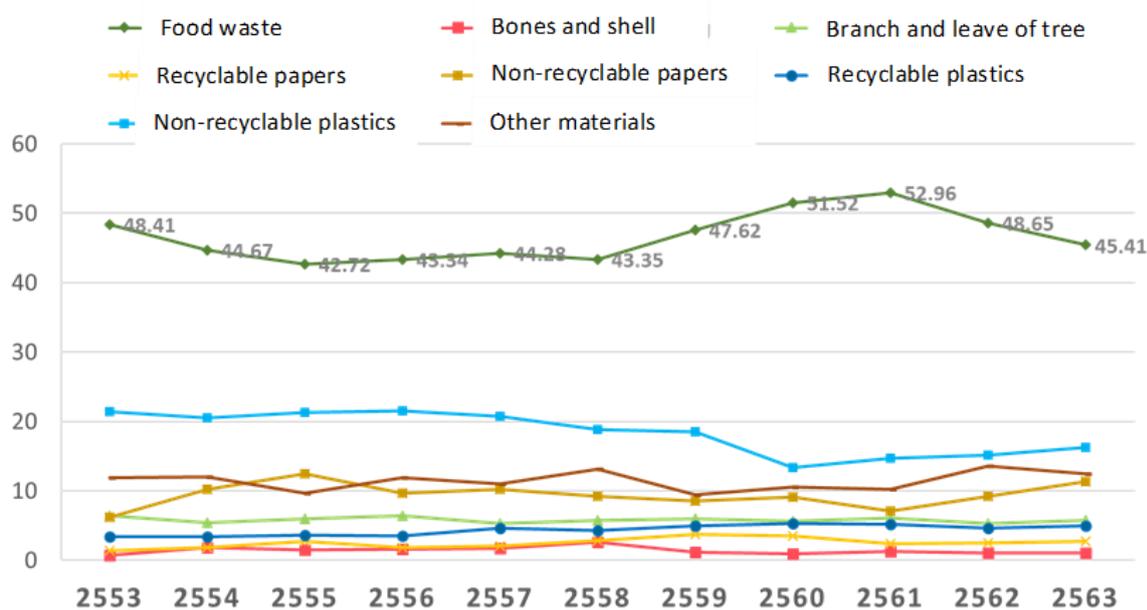
According to the study review for scoping this report, it found that the framework for food waste management capable to be applied to food consumption chain analysis of Bangkok will be divided into 3 parts, consisting of;

- 1) **Food distribution** – hypermarket, supermarket, convenient store, and market; mainly due to fresh food and short-lived products that deteriorated, damaged products from customer’s behavior, products with the shapes are not according to the criteria, and nearly expiration date which are discarded. In addition, there are leftover products due to market competition and poor economic conditions.
- 2) **Food services** - hotels, restaurant, food court, cafeteria, catering service; mostly are scraps from the food preparation in the kitchen and are discarded, as well as leftovers from the party and leftover food on the customer's plates.
- 3) **Households**; it is found that general residence in horizontal style has a higher rate of waste per person per day than those in high-rise buildings or in a verticle style, because of they are bigger family and more frequently cooking. In addition, most of the food wastes found in the kitchen, expired food, deteriorated food, and the leftover food on the plate, respectively.

## 1.2 Food Waste Situation in Bangkok

The amount of solid waste generated in Bangkok tends to increase continuously. The highest volume in 2018 was 3.91 million tons or 10,705 tons per day, accounting for 17% of the total waste generated in the country. Then, the amount of waste in Bangkok was reduced in 2019 and 2020 to 3.85 million tons and 3.48 million tons, respectively, due to the COVID-19 pandemic situation with the use of lockdown measures and many businesses were temporarily closed. A number of people returned to their homeland and there were no foreign tourists visiting Thailand for a period longer than a year. However, during the COVID-19 pandemic, the non-recyclable plastic waste or plastic not worth recycling, as well as non-recyclable paper have been increased. This has the linked to online food ordering behavior with a large use of plastic and paper packaging. When those packages are contaminated with food and grease, there is a difficult process to recycle, therefore they are being discarded together with general waste.

Regarding food waste that occurred in Bangkok during the past 10 years, the proportion was in the range of 42-52% of the waste generated (as shown in the picture), with the trend of food waste changing in line with the change of total amount of food produced in Bangkok. The amount also declined during 2019 and 2020. It is not yet clear where most of the food waste came from because there is no clear data collection system.



**Figure:** Proportion of food waste and other waste types in Bangkok area during 2010-2020

**Source:** Data form Department of Environment, Bangkok Metropolitan Administration (BMA)

About 1,600 tons per day of waste produced in Bangkok are composted by the disposal system at On Nut sistrict with composting technology supports 1,000 tons per day, and organic composting plant supports 600 tons per day. About 320 tons per day of food scraps are collected and fed to animals. Hazardous waste includes the remains of electrical and electronic products will be disposed of by incineration by Akkie Prakan Public Company Limited. Infectious waste will be burned by Krungthep Thanakom Company Limited at On Nut. The waste that occurs in the southern zone of Bangkok, some

will be disposed of at a waste disposal plant that generates electricity for the environment which is an incinerator system at Nhong Khem district that can support 500 tons per day. Additionally, BMA will manage the remaining waste to landfill located in Chachoengsao Province and Nakhon Pathom Province.

For the causes of food waste, from the interviews with relevant stakeholders and review of relevant studies which used to conduct surveys about the occurrence of food waste from various groups in Bangkok. Through the interviews with entrepreneurs and observation of activities in the sample areas are as follows:

### 1) Food distribution

- **Transportation problem;** most supermarkets have a system to return products damaged in transit. The damaged products mostly on the packaging such as the product label is broken which must be eliminated. And often there is a problem with the large markets that are purchased by contractors and long-distance transport.
- **Product storage problem;** it is often a problem of large markets with selling place for wholesale products without proper management. In the small markets, there is not enough storage equipment. Other problem includes markets without air conditioning system causing damaged to vegetables and fruits easily.
- **The problem of deteriorated short-lived products;** occurred in supermarkets and convenience stores, products such as milk, ham, short-lived products that are close to expiration are regularly discarded and especially in the markets without refrigeration system.
- **Security requirements issue;** causing the need to eliminate food products that are not suitable for each company's distribution, contribute to increased food waste, damaged or scratched packaging causing the entire package to be disposed of even if the product inside is not deteriorated or damaged.
- **Customer behavior problem;** usually occurs in supermarkets and convenience stores where products are placed on shelves for customers to choose for themselves, where the product is touched and damaged.
- **Employee shortcomings;** supermarkets and convenience stores change employees frequently. Employees in some establishments are migrant workers who do not yet understand.
- **Economic competition problem;** supermarkets and stores that sell the same products would have regular promotions to attract customers, causing food products may not be sold out and deteriorated.
- **Problems with the shape of agricultural products;** which are mixed in size, color, and shape that do not meet the criteria. It's a big wholesale market problem with a big lot or wholesale purchasing and then select the products that do not meet criteria out later.
- **Problem of disposing expired and leftover food;** some establishments have regulations that have to dispose leftover food. They don't donate due to fear of affecting the image of the organization if there are complaints which would be difficult to control.

## 2) Food services

- **Transportation problem;** for the hotels or large restaurants, there will be a purchasing department to manage the damaged foods in transit. Smaller restaurants tend to buy by themselves from nearby vendors, therefore, there is rarely a problem from transportation.
- **Product storage problem;** it is found in small restaurants that do not have enough equipment to store the foods. Weather has become another factor when at certain times it might be too hot.
- **Customer behavior problem;** leftover foods on the plate caused by ordering too much, or over taking the buffets, or ordering food to try and doesn't taste good.
- **Employee shortcoming;** when the staff wrote down the details of the orders that did not match what the customers ordered, causing food returning. This also include changing of the person responsible for cooking which can change the taste of food.
- **Problem on raw materials left from cooking;** most cooks would use only some ingredients in cooking process, and the rest must be discarded. While there are some large hotels or restaurants having menu where almost all parts of the ingredients and even the excess food from the sales can be used to make other dishes.

## 3) Households

- **Problem from the lack of planning for food purchase;** lack of food inspection on what are available or necessary, as well as from the store's marketing strategy that stimulates sales, causing consumers to buy more than necessary to them.
- **Food storage problem;** both on storage in the temperature is not suitable and the lack of a proper food storage system, causing food residues to deteriorate.
- **Confusion over food age information;** there is a misunderstanding or confusion between the symbols "Best before" and "Expiry date", on what is the difference between these two symbols?
- **Problem of refusing to accept products with unusual shapes;** such as distorted fruit, alkaline color, will be discarded because no consumer will purchase these products.
- **Problem with raw materials from cooking;** cooking is another stage of household food waste from cutting, decorating or discarding inedible parts such as mature leaves, vegetables with not good appearance, hard stems or roots that are not edible. Some parts would only be used as ingredients in the cooking process, the rest must be discarded without knowledge of other uses or not at all paying attention to those raw material scraps.
- **Problems from preparing and scooping too much food;** lack of planning and lack of caution causing food waste.
- **Food waste management problem;** most of which are still disposed together with general wastes, because people do not see the importance and are not sure if food waste is segregated how it can be discarded. Even if the Ministry of Interior has promoted the use of fermentation tanks but it is not suitable for households in Bangkok with little space.

## 1.3. Policy Analysis and Stakeholder Mapping

This part identify all stakeholders related to the food consumption and food waste management in Bangkok. There is an identification what has worked, what has not worked in the past policy and action.

### 1.3.1 Relevants Policy Analysis

Bangkok Metropolitan Administration (BMA) is a special local administration organization (LAO) in Thailand, and it is the only one LAO that the jurisdiction covers the whole province. The Bangkok metropolitan Administration Act, B.E. 2528 authorizes the metropolitan to manage, provide and implement the tasks under their responsibilities.

BMA is implementing the 20 years Bangkok Development Plan, B. E. 2556-2575, and the 5 years Development Plan. The periodically 5 years' development plan identifies work plan and project for implementation, which include waste management plan. However, BMA's development plan needs to link with national development plan that aims to achieve sustainable development goal (SDGs), which targets food waste reduction. The national plan and policy relevant to food waste management include national master plan under national strategy (B.E. 2561-2580), National Reform Plan on Natural Resources and Environment, Policy and Plan on Promoting and Conserving National Environment, B.E. 2560-2579, Environment Quality Management Plan, B.E. 2560-2565, 20 years Pollution Management Strategy, Pollution Management Plan, B.E. 2560-2564, and the revised Sustainable Production and Consumption Driving Plan, B.E. 2562-2579. Draft Action Plan on Mobilization of National Development with BCG Model (2021-2027), and the 20-year Plan for Bangkok Development.

#### Thailand's 20-year National Strategy (2018 - 2037)

Of 18 master plans in the National Strategy, the master plan on sustainable growth sets targets and provides guidance on waste management. The master plan also calls for systematic inspection and review of nationwide waste management, promotes private investment in management of waste and hazardous wastes and encourage research, development and application on waste reduction and disposal under the plan on research and development of environmental innovations.

#### The Plan for National Reform

The Plan for National Reform on Natural Resources and the Environment emphasizes change in consumption behaviors and elimination of byproducts and proposed carrying out feasibility studies on and developing waste segregation systems. The plan also set target to reduce organic and recyclable wastes and increase reuse as well as calls for cooperation with private sector to seek out means and ways to utilize wastes, The plan further promotes provision of skills and knowledge on waste segregation to communities and schools by incorporating such knowledge in school curriculums in addition to conducting feasibility studies and developing plans for segregation of organic waste including by putting in place segregation systems for waste collection and transportation in city municipalities, industrial towns and large tourist areas (in the initial phase).

### **The Twelfth National Economic and Social Development Plan (2017-2022)**

A strategy for eco-friendly development and growth in the Twelfth National Economic and Social Development Plan prioritizes waste management at local and provincial levels by emphasizing holistic approach on the management from waste reduction, promoting mechanisms for waste segregation, maximizing reuse to using wastes for power generation. The strategy also calls for building consumer awareness and providing sufficient and accurate information on waste management.

### **The National Policy and Plan on Promotion and Conservation of National Environmental Quality (2017-2036) and the National Plan on Management of Environmental Quality (2017-2022)**

The Policy and Plan calls for gathering of data and development of additional policies on food lost in production and consumption as well as development of mechanisms to reduce food waste in food outlets, households and those in between. **The National Plan on Management of Environmental Quality** consists of a strategy on food lost and food waste as well as supports and promotes participatory efforts to reduce food waste by the state, private and civil sectors. The Plan places the emphasis on large cities and tourist sites and proposed a holistic approach to reduce food waste in production, distribution, transportation, processing, service, household consumption and disposal.

### **The 20-year Strategy for Pollution Management (2017 - 2036) and the Pollution Management Plan (2017-2021)**

The official direction for pollution management places the focus on prevention and mitigation at sources including by enhancing effectiveness of treatment, developing systems for pollution management and reducing food waste throughout the entire supply chain within 10-20 years. The National Master Plan on Waste Management (2016-2021) was formulated in response to a national agenda on waste and places an emphasis on reducing wastes at their origins and enabling reuses. The Master Plan is without clear guidance on food waste, however.

### **The 2017-2037 Sustainable Consumption and Production Roadmap (the first revision)**

The Roadmap adopted the 12<sup>th</sup> Goal of SDGs to current national circumstance and identified food waste as a target for actions in urban areas and by local administrations. The Roadmap calls for national efforts to reduce food waste and establishment of data systems to support the efforts. The Roadmap also took note of the facts that around a half of the country's population are living in urban areas, resulting in high level of consumption and generation of food wastes which has significant social and environmental impacts. Emphasis was thus placed on local administrations who have authority and best capacity to effectively address the problem.

### **The draft Action Plan on Mobilization of National Development with BCG Model (2021-2027)**

The draft Action Plan consists of a strategy to elevate competitiveness of 5 industries including agriculture and food sectors. The strategy places an emphasis on addressing food lost and food waste by improving production process, enabling reuse and recycle and developing environmentally sound packaging that prolongs shelf-life.

### **The 20-year Plan for Bangkok Development**

Bangkok Metropolitan Administration (BMA) has formulate and implemented the second phase (2018-2022) of the 20-year Plan for Bangkok Development. The 2<sup>nd</sup> phase includes a strategy to

enhance effectiveness of waste management at the sources and aims to dispose, treat and recycle 100% of waste by the end of the phase (2022) including by using solid waste incinerators for power generation, composting and anaerobic digestion.

For waste and food waste management in Bangkok, the BMA functions under the authority as indicated in the Bangkok metropolitan Administration Act B.E. 2528. Besides, there are the Determining Plans and Process of Decentralization to Local Government Organization Act, B.E. 2542, Public Health Act (3rd revision), B.E. 2560, Act on the Maintenance of the Cleanliness and Orderliness of the Country, B.E. 2560 as well as announcements under these acts.

From the analysis of relevant policies, plans and laws, it is found that,

- 1) **There are national policy and plan that focus on reduce food waste generation and reduce amount of food waste** by making work plan and indicate clear operational goal. Paying attention on food waste management at the original source. Besides, the policy's direction also promotes the participation of private sector. There are studies on food waste segregation and develop food waste management innovation, which aim to suit with urban lifestyle by starting from big cities, industrial cities and tourist destinations. Recently the relevant agencies are preparing the draft of national food waste management navigation plan, which is scheduled to complete on B.E. 2564 and follows by the draft of national food waste management operation plan.
- 2) **There is no clear food waste management goal in Bangkok Metropolitan Development 5 years Plan, B.E. 2561-2565.** There is the strategy to increase overall efficiency in waste management, reduce amount of waste, and promotion of waste segregation, and increase waste utilization at the original source at 30 percent within B.E. 2565. Establishing criteria on organic waste segregation and utilization of each district office. Most of organic waste management is collection of fruit and vegetable wastes from market to make compost as it is convenient to collect and transport.
- 3) **There are national waste management measures but not cover all aspect.** Most of the measures are promotion measures following 3Rs principles but controlling measure for waste segregation or waste disposal from large establishment is missing. Such issue is an operational gap. Moreover, lack in existing law on remain food or food waste donation, no incentive of food donation neither tax or fee reduction. If there is a regulation to protect food donor, it will effect recipient's health.
- 4) **The BMA environmental policy results in the continuous waste proportion survey.** Since B.E. 2552, the survey shows trend of amount and proportion of food waste. Meanwhile, there is also a research to develop amount of food waste assessment and national survey on amount of food waste, which leads to target determination and monitoring. There is a concern that data collection during COVID-19 pandemic might be error compare to in normal situation. However, the BMA might need to adjust the survey method to comply with national level. Moreover, there is a need to study proportion of food waste from different sources to make an operational plan in accordance with current situation.

In addition, the BMA has also set indicators for the district offices on waste utilization. It drives various district offices collect and compost vegetable and fruit scraps from the market, and then use it to nourish the soil in the park and along the roadside trees. It's a good initiative which has helped to reduce the amount of waste, even it is only a very small proportion.

- 5) **MBA does not have clear local ordinance to control food waste at a source.** Recently the metropolitan is campaigning and managing waste from original source and provides waste bin, collect and dispose without relevant laws to control food waste at original source. The ministerial regulation on restaurant hygiene, B.E. 2561 indicated that the restaurant must segregate food waste in accordance with local ordinance on waste management in restaurant. However, local administration office and BMA do not impose their own ordinance, hence; there is no control in this matter. Moreover, there is no local ordinance to control restaurant and food storage place, and market on food waste reduction and segregation.

According to the relevant stakeholder’s consultation hold this year (2021), there is a need to separate waste before disposal, waste disposal control, supporting surplus food donation, creating incentive measures to reduce and manage food waste at its source. As previously, there is mainly promotion measure but no incentive and control measures. This impedes a progress in waste management as a whole. Besides, public is not convinced that responsible agency handles waste and segregates it properly, then the public does not comply with waste segregation practice at the original source.

### 1.3.2 Stakeholders Mapping

The key stakeholders that involved in food waste management in Bangkok comprised of public sector, private sector, people and others, and can be classified according to the roles and responsibilities in the operations of those sectors related to food waste management as a whole have been identified. Including the role involved in the management of food waste. It covers food distribution, food service and household sector. The list can be summarized as shown in the Table 1.

**Table 1** Key stakeholders relevant to food waste management in Bangkok

	Public sector	Private sector	People and others
Overall	<ul style="list-style-type: none"> <li>• Office of Natural Resources and Environmental Policy and Planning (ONEP)</li> <li>• The Pollution Control Department (PCD)</li> <li>• Bangkok Metropolitan Administration (BMA)               <ul style="list-style-type: none"> <li>- Environmental Department</li> <li>- District Offices</li> </ul> </li> <li>• Thai Health Promotion Foundation (ThaiHealth)</li> <li>• National Science and Technology Development Agency (NSTDA)</li> <li>• Office of National Higher Education Science Research and Innovation Policy Council (NXPO)</li> </ul>	<ul style="list-style-type: none"> <li>• The Thai Chamber of Commerce (TCC)</li> </ul>	<ul style="list-style-type: none"> <li>• Academic institutes</li> <li>• Research institutes</li> <li>• Mass media</li> <li>• NGOs</li> <li>• Care homes for under privileged</li> </ul>

	Public sector	Private sector	People and others
Food distribution	<ul style="list-style-type: none"> <li>• The Market Organization (MO)</li> <li>• Department of Health (DOH)</li> </ul>	<ul style="list-style-type: none"> <li>• Thai Retailer Association (TRA)</li> <li>• Thai Fresh Market Association</li> <li>• Hypermarkets</li> <li>• Supermarkets</li> <li>• Convenience Stores</li> <li>• Markets</li> </ul>	<ul style="list-style-type: none"> <li>• Customers</li> </ul>
Food service	<ul style="list-style-type: none"> <li>• Office of Bangkok Metropolitan Administration Market</li> <li>• Department of Tourism (DOT)</li> <li>• Department of Environmental Quality Promotion (DEQP)</li> <li>• Thailand Convention and Exhibition Bureau (TCEB)</li> <li>• General government agencies</li> </ul>	<ul style="list-style-type: none"> <li>• Thai Hotels Association (THA)</li> <li>• Hotels</li> <li>• Restaurants</li> <li>• Food courts</li> <li>• Catering services</li> </ul>	<ul style="list-style-type: none"> <li>• Service users (general people or organizations)</li> </ul>
Household	<ul style="list-style-type: none"> <li>• Department of Education, BMA</li> <li>• Social Development Department, BMA</li> <li>• National Housing Authority (NHA)</li> <li>• Department of Environmental Quality Promotion (DEQP)</li> </ul>	<ul style="list-style-type: none"> <li>• Residential Juristic Person</li> <li>• Housing estate</li> </ul>	<ul style="list-style-type: none"> <li>• Households</li> <li>• Temples</li> </ul>

At present, implementations on food waste management in Bangkok area by the BMA and related stakeholders (listed as annex) have achieved some progress, however there are some weaknesses that need to be reviewed and improved as follows:

#### Progress of implementations

- Key stakeholders that play a role in food waste management in Bangkok through the implementation of projects or activities, are in line with the government's policy on waste management at the primary source. In addition, several organizations have started to focus on reducing the amount of food waste.
- There are several non-governmental organizations in Bangkok accept food donation from hotels, grocers, restaurants, and other suppliers and deliver to communities. They help to minimize unnecessary loss of surplus food and food waste from related businesses.
- Retail and wholesale businesses, hotels, food courts and educational institutions have various ongoing operations, although such activities only occur in small number of organizations. The large organizations learn to modify their packaging to withstand damage and prevent direct contact from customers, etc.

- Some private stakeholders have clear policy to minimize food waste. They start to record and use food waste information to plan and track their performance. Most of them produce the operational guidelines for employees and members of the organizations.
- Government organizations have the promotion and reward for the environmental organizations who meet environmental criteria. Those criteria are also including the food waste management performance, such as green hotel, green temples, green markets, zero waste communities, zero waste schools and green cities. Such criteria can help to upgrade the operations of various groups, lead to establishment of learning center for interested parties.

### Gaps and constraints

- The limited communication on the type of waste and waste segregation causing people to confuse on the differences between wet waste, fresh waste, organic waste and food waste, as well as the methods to dispose each type of waste. In addition, people are not convinced that government agencies will have appropriate waste segregation and management practices, therefore they tend to not cooperate in waste segregation.
- BMA does not have a plan on food waste management. Even though, there is a data on amount of food waste, however this data won't be used in the planning or setting a preventive measure to reduce food waste effectively.
- BMA is still unable to dispose of large amounts of food waste. This is a limitation in promoting waste segregation from various sources. Therefore, there are no local regulation requiring food waste to be segregated. Despite BMA has an authority to control food distribution and storage facilities and marketing according to the Public Health Act to reduce and segregate different types of waste, including food waste.
- The promotion on organic waste composting at the household level is a very unsuitable choice for Bangkok society due to space and time limitation, as well as lack of knowledge on the procedure.
- The discontinuous public relations to educate the public had been conducted by only some organizations and had very little influence and impact.
- There is a few support in research and development on preserving and extending the life of food products. However, most of the research results have not yet been implemented. In addition, there is no development of technology, equipment, and innovations for food waste disposal that would be suitable for district and sub-district levels.

Currently, food waste management is not well known in the Bangkok society. Even though people said it is their own duty but they still dispose of food waste together with general waste. Because they are not encouraged to practice and also lack of diverse alternatives that are suitable for the context of Bangkok. As for key stakeholders, there is no clear cooperation in working with food distributors, food service providers and consumer groups to prevent and reduce food waste. While Bangkok emphasizes the mission of collect and dispose all waste occurred. There are still gaps that need to be accelerated on the aforementioned issues to increase efficiency in food waste management in Bangkok intensively.

## 2. A STUDY ON THE USE OF TECHNOLOGY ON FOOD WASTE MANAGEMENT

*This section presents a tailored case studies of enablers for improvement technical solutions, and economic incentives and behavioral interventions to address the waste issue from the food supply chain in Bangkok.*

Modern technology plays an important part in daily life of humans and business operators including those associated with production, service and consumption. In addition to introduction of machinery and electronics, technology has facilitated adoption of knowledge to yield practice benefits, increase working capacity, shorten time for travel, lengthen and widen field of vision, raise food production and allow food to be preserved for longer period of time.

Concerning food waste problem in Bangkok, a half of all waste generated are disposed by local authority (BMA). The disposal reportedly contributed to greenhouse gases emission and caused various social, economic and environmental problems. It is likely to be time-consuming for multiple sectors associated with food production, retailing, service and consumption to become fully aware of and take actions to address the problem. Adoption of technology is thus a viable option that should be considered for management of food waste as well as for communicating and networking relevant news and information on food waste management.

### 2.1 A survey on adoption of technology for management of food waste in Bangkok

A survey was carried out on an online platform during May 10-19, 2021. One hundred and ninety-two individuals participated in the survey. Seventy-six percents of participants were females while the other 24% were males. Most were found to belong to working population (36-60-year-old) and most were organizational staffs.

#### The result of survey presents;

- 1) **The top 5 common food wastes in their thought are** (1) leftover from meals, (2) rotten food, (3) food that doesn't meet quality standard, (4) food products with expired date, and (5) unsold food.
- 2) **The top 5 places where reduction of food waste should be promoted are;**
  - (1) Residents where efforts could start at household level and then expand to community level and beyond,
  - (2) Cafeterias and food courts in agencies, colleges, department stores and schools where management of food waste could be facilitated by collective nature of the facilities and by employees who have interest in the management,
  - (3) Markets where large amount of food and organic wastes generated required sound management and further efforts could build on BMA's pre-existing actions in these facilities,

- (4) Schools where children could be made aware of and engaged in management of food waste
  - (5) Others including temples, meeting hall and dining halls.
- 3) **Top 5 methods for reducing and managing food waste in business and household** are (1) pre-planning in purchasing and cooking, (2) well food storage, (3) segregating wastes for composting, (4) feeding the waste to animals and (5) disposing as natural fertilizer.
  - 4) **Top 5 technologies for mitigating food waste problem in Bangkok** are those associated with (1) waste disposal in households and restaurants, (2) communicating and campaigning, (3) databases on food waste, (4) food preservation and (5) food stock management.
  - 5) **Notable technologies for reducing food waste identified in the survey** include an online application to calculate cost of food disposal, "First in -First out" information system, composting containers for household use, dryers for animal feed, food shredders, building connection between food donation networks and town level and providing for food waste collection trucks usde in Milan's model for management of food waste.

The survey found the participants to be aware of the need to address the problem of food waste. They were of an opinion that the problem in Bangkok is largely derived from the lack of waste segregation. The participants further took note of an absence of clear policy, insufficient information and poor adoption of technology to campaign for and take effective actions on the problem and recommended BMA to adopt policies and measures and to appoint a agency on the issues. Such actions may include building databases, setting benchmark for food waste to carry out comparative assessments with situations in oversea, providing guidance on food delivery to reduce waste, introducing waste management technology and promoting waste segregation including by providing more waste bins.

## 2.2 Case study on technological solutions

The project conducted an inventory on diverse case studies associated with technological solution for management of food wastes. Those involved in the case studies were invited to 2 seminars hold on May 20 and August 3, 2021. In addition to study on households' food waste management, the project identified notable cases on adoption of technologies and other methodologies in food production, service and consumption, ranging from those associated with reduction to disposal of food waste. They can be listed as follow;

- |   |   |
|---|---|
| 1) Central Group                          | 7) Food Intel Tech (FIT) Application                |
| 2) Tanommit Market                        | 8) Yindii Application                               |
| 3) Eden Agritech Co., Ltd.                | 9) Clear Plate Application                          |
| 4) Chulalongkorn University's food courts | 10) Scholars of Sustenance Thailand (SOS)           |
| 5) Mullika Inter Food Co., Ltd.           | 11) Uncle Ree's Farm                                |
| 6) Baan Tapa Culinary Space               | 12) Study results on Household Food Waste Reduction |

## Central Group



Central Group is a conglomerate with clear policies and action plans on reducing waste (and food wastes) in hotels, restaurants and, particularly supermarkets. The firm prevent waste generation by adopting auto replenishment system to check exiting stock, control restocking and identified products with expired date. Excess stock of food products were donated and Central's department store in Bangkok segregated their food waste so that they would be turn into compost by the BMA. Operators were requested to daily record and report amount of segregated waste to the headquarter

with waste management application in order to assist planning while chefs in hotels were asked to minimize waste in preparing meals and to make most efficient use of ingredients.

In addition, waste segregation was reportedly carried out every morning by Family Mart convenient stores on Samui Island of Surat Thani Province. Edible products were donated while the rest was used in generating biogases with COWTEC machine and for composting. The biogases were utilized for cooking by Wat Lamai Municipality School and a tourism college and the compost was used for organic farming.

## Tanommit Market



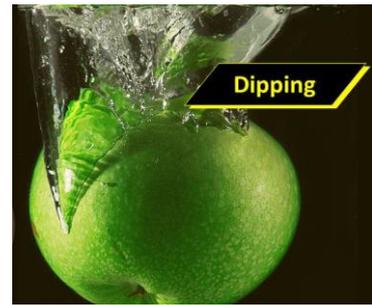
This markey comprised of approximately 1,000 outlets. Since most sell fresh food and pre-cooked meal, each was provided with segregated bins. Fruit and vegetable wastes were used in generating biogases. Wastes from butchers and those high in fibers were usually turned into compost. The conventional process of composting is, however, time-consuming and use up relatively large space. A technology was

therefore adopted to chop-up the wastes before composting them for 2 weeks. Bio-agents were made for cleaning the market. Coconut coir was fed into grinders and turned into bio-fertilizer while coconut endocarp (shell) was used as a container for growing basil and other vegetable.

The market reportedly handed out coupons to sellers who segregated their waste. The coupons were given to their customers and could be exchanged for products made from coconut coir, compost and bio-agents. The action was well-received and some customers were found to be so please with the products that they were willing to make purchase for the products themselves.

### Eden Agritech Co., Ltd.

The company who exports fruits and vegetable developed Naturen, a natural extract, to extend shelf life of their products. The extract combines biological and film technologies to produce edible coating. Nuturen can be applied by dipping or spraying and creates coating that is invisible to naked eyes. The coating regulates surface contact with water, air and other gases, extend the products' expiring date by 5 times, slows growth of microbe and preserves vitamins and other nutrients in the products.



The firm adopted Sustainable Development Goals (SDGs) as guidance for meeting multiple business targets by looking beyond lengthening life of fruit and vegetable products and aiming toward contributing to preservation of Earth and communicating messages on sustainability.

### Chulalongkorn University's food courts



The management of food waste in Chulalongkorn University is under a project entitled "Chula Zero Waste". The project initially conducted an inventory on quantity and composition of wastes then identified 2 target groups, consumers and food providers and finally, carried out campaigns for segregation of food waste including by making available waste bins for food. Leftover was found to be the main obstacle against enabling substantive reduction of food waste and a campaign was organized to promote ordering "just-enough" to eat in addition to efforts to communicate clearer messages and to reward outlets with good records on food waste segregation.

Food waste from consumers (mostly from cooked meals) was segregated, collected and used for feeding fishes by farmers in adjacent provinces (Ang Thong, Samut Prakan, Ratchaburi and Suphan Buri Province). The waste from outlets (mostly fruit and vegetable) was mechanically turned into biomass used as materials for soil improvement while waste liquid was used in making bio-agents. The materials and agents were utilized in maintaining vegetation in the campus.

### Mullika Inter Food Co., Ltd.



Mallika has been managing 27 restaurants for over a decade. The firm planned and managed the entire supply chain of the business from acquiring food from markets and the firms' organic farms in Lopburi Province, storing and distributing products to retrieval of food waste and byproducts. Most food waste was found to derive from leftovers, unused vegetable and bakery products with expired date and the waste was used in generating biogases while waste liquid was turned into bio-fertilizer and used in vegetable farms in Lopburi Province. Biogases generation was, however, found to be inefficient when waste composition of carbohydrate, protein and plant fiber is unstable or the waste consists of too much vegetable and the firm was found to be interest in acquiring

machine to product fertilizer from food waste with 24 hours. The price tag on the machinery remained relatively high, however.

Lemon peels were used in producing a bio-agent which was used with dishwashing liquid in grease traps and wastewater treatment ponds. A mixture of vinegar and rice whisky was used as pesticide, coconut coir was sold as an animal feed and coconut endocarp was used as a container for growing plants at farms in Lopburi Province.

### Baan Tewa Culinary Space

This restaurant directly communicated with farmers at least 3 months before including new additions into the menu. The restaurant's chefs were encouraged to create new dishes with indiscriminate on ingredients and to make full use of existing ingredients including leftover pieces of meat and pork and fermented fruits and vegetable. They were also asked to figure out how to make use of inedible materials such as coriander stalks, fish bone and fish gut. With these measures, very little waste was generated in preparation of dishes, signifying the importance of creativity in adding news items in the menu and in learning way and means to make good use of unutilized materials.

Most food wastes in restaurants derive from over-purchasing and the difficulty in estimating demand of customers on daily basis. Better assessment of daily need for ingredient is thus required. Food



waste should also be carefully segregated for reuse and for composting. Composting itself requires turning the mixture over on weekly basis and the compost is generally used in growing vegetable in backyards.

### Food Intel Tech (FIT) Application

FIT application was developed by LightBlue Environmental Consulting Co., Ltd. for recording and conducting in-depth analysis on food waste in order to reduce generation of the waste and calculate disposal cost. The application requires information on weigh, amount, type and origin of food waste as well as on meals and other cause associated with the waste generation. The application displays situation on food waste based on comparative analysis with base-year data, provides weekly summaries on food waste and reports on greenhouse gases emission.



Fifteen hotels and restaurants in Bangkok were found to be using FIT which reportedly reduce food waste in the restaurants by 51.6%. The application was also noted for enhancing capacity to plan for effective reduction of food waste in kitchens, building awareness on the waste's impacts on the environment and reflecting cost of food waste on hotel and restaurant operators.

## Yindii Application

Yindii was found to assist hotels or restaurants in selling their excessive stock of food or nearly expired food products to consumers at cheaper price so that they might not turn into food waste. Around 150 hotels and restaurants were found to be using the application and consumers can pick hotels or restaurants of their choice and place reservation on food products during the day. The products are packaged and can be delivered or picked up in the evening. If the orders are sold out, the establishments are to replace them with other similar products.

Yindii communicates to younger consumers on how much contribution they made on mitigating greenhouse gases emission by using the application, a customer survey found that 80% of the customers had been unaware of environmental impacts from food waste before using the application and the application was thus instrumental in communicating the message.



## Clear Plate Application

Clear Plate is an application used in China to reduce leftovers in each meal. The users are required to take pictures of their plates after their meals and points are rewarded for not having any leftover. The points can be collected and exchanged for prices or used to donate meals for those in need. The application has become a tool for reducing food waste in multiple organizations. By using the application, over 10,000 leader boards were set up in universities, restaurants, firms NGOs ad state agencies to display ranking of contributors to reducing of food waste (leftover).



Clear Plate also organized activities in more than 2,000 universities on World Food Day to campaign against food waste. The activities were participated by millions of students. Clear Plate was found to place the focus on younger generation in efforts to reduce greenhouse gases emission by engages with students and celebrities.

## Scholars of Sustenance Thailand (SOS)

SOS is a non-profit organization who collect donation of quality food leftover from hotels, department stores, food factories, restaurants and shops in Bangkok, Phuket Province and Hua Hin District of Prachuap Khiri Khan Province. The food was picked up at the establishments, checked for safety, kept in storages with temperature of 3-4 Celsius and then distributed to orphanages, foundations for the underprivileged, low income communities, hospitals, aid centers and homeless shelters.



SOS staffs were noted to use an application to record weigh of each type of food on daily basis in order to assess the operation and its impacts, plan for logistics and report back to donors.

## Uncle Ree's Farm



This farm has raised earth worms in Bangkok for 7 years and placed a particular interest on management of food waste. The farm had taken note of the large amount of fruit and vegetable waste and farmed the worm to dispose them. Wastes from neighboring restaurants and outlets, including soybean and egg shells, were also use as substrates in raising the worms in containers. The substrates are covered with rice husk, vegetable waste and cow manure and the containers is protected by nets

and watered once a week to maintain moisture. Of several species used by the farm, African Nightcrawler (*Eudrilus eugeniae*) was noted for producing excreta that can be used to fertilize vegetable, providing that the species is fed with vegetable waste.

Vegetable fertilized with the worms' excreta was harvested and delivered to restaurants. Such practice allows the farming to operate in circular fashion (since vegetable was grown with waste from the restaurants). It should be noted that the farm itself does not use much space, is compatible for urban setting and has good access to restaurants.

## Study results on Household Food Waste Reduction

The article on “Integrated Strategies for Household Food Waste Reduction in Bangkok” written by Pongsun and Chen (2021)<sup>1</sup> showed that pre-purchase checks can not only prevent food waste but can also increase the reuse or recycling of food waste. Citizens with higher levels of education and those showing more concern about social issues and global warming are more likely to separate food waste before disposal and to participate in reuse or recycling activities.

Finally, this paper proposes a seven-stage actionbased model of integrated strategies for improving household food and food waste management to prevent or reduce food waste generation as well as remedy existing policy gaps in Bangkok. The steps start with pre-shop planning, carefully shopping, storage and preservation of freshness, well skill and knowledge cooking, eating habits, processing of leftovers, and food waste recycling.

In addition to gathering information for planning on reducing food lost, increasing distribution of leftover and building motivation to minimize food waste among consumers and operators, technologies were found to be applicable in turning food waste into fertilizers, preserving nutrients and extending shelf-life of food products. They were also noted for enabling environmentally sound production and supply chains such as mitigating greenhouse gases emission from transport and reducing waste from packaging.

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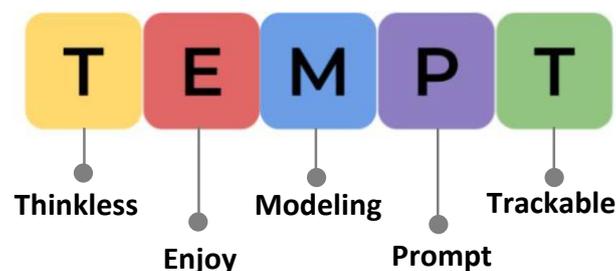
<sup>1</sup> Bunditsakulchai, P.; Liu, C. 2021. Integrated Strategies for Household Food Waste Reduction in Bangkok. Sustainability 2021, 13, 7651. <https://doi.org/10.3390/su13147651>

## 2.3 Application of economic incentives and behavioral interventions

Change in daily behavior has as much impact on the environment as any production activity in any sectors. Such impact can be seen in food consumption where food waste constitutes lost of natural resources and energy for food production and transport and generates byproducts that are detrimental to environmental quality.

Study on changing behavior associated with food waste adopted Behavioral Economics which combines behavior science and economics to investigate underlining basis of human behaviors in order to design choices for decision-making. Such concept includes “Nudge Theory” introduced by Richard H. Thaler, the Professor of Behavioral Science and Economics at the University of Chicago Booth School of Business. Nudge theory proposes positive reinforcement and indirect suggestions as ways to influence the behavior and decision-making of groups or individuals.

Nudge Thailand proposed the “TEMPT”, as a simple concept based on relevant researches on Behavioral Economics, as guidance to change behaviors on food wastes and their segregation. The concept requires identification of target groups, their behaviors and other associated information as well as determination on what aspects of behaviors that require change. Actions to change behaviors are then designed, tested and evaluated. To this end, success of actions on particular target groups or areas might not be replicable for other groups and/or areas. TEMPT can be summarized as follow;



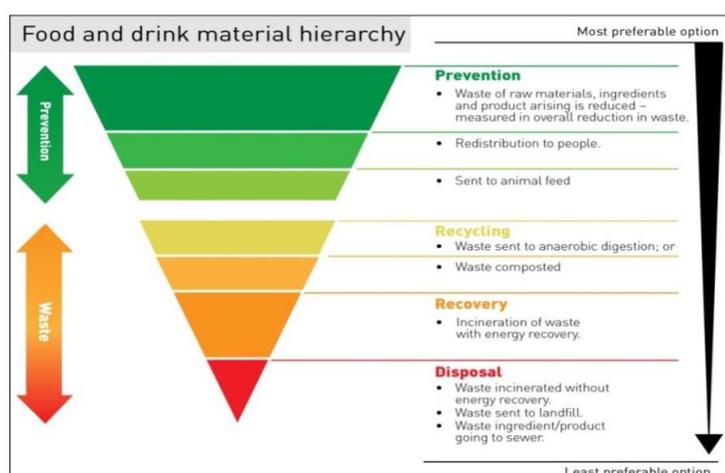
- **Thinkless** = The slightest of difficulty or obstacle that require thinking often discourage people to follow. Default setting with predetermine choice is preferable while having checklists ease efforts to follow any process when being under pressure. This concept can be adopted for food delivery where default setting makes addition orders more troublesome or for buffet where having only small plates available discourages taking too much food. Food store can also adopt the concept by making nearly expired food more accessible.
- **Enjoy** = Attractiveness of betting for major price without regarding actual possibility of winning can be adopted providing that the design is effective in bring out challenging nature of people. The concept can be used in designing eye-catching rubbish bins for segregation of food wastes, selling nearly expired food products as random price and rewarding for not leaving any leftover.
- **Modeling** = People often measures up to others who have done better and follow social norms of the mass. This concept can be adopted in organizing bargaining food sales with large number of people lined up to make purchase or communicating model initiatives such as making an announcement on becoming a leader in reduce food waste and drawing attention of other retailing, hotel and restaurant establishments in committing to such reduction.

- **Prompt** = Being timely can establish commitment to immediate actions and sudden acts can be stimulated with words, sound, smell or image. This concept can be adopted to discourage having leftover by continuously feeding images on food waste problem.
- **Trackable** = To ensure continuation from the start until the completion in timely fashion requires setting *deadline* while reflecting on progress does compel people to meet targets. The concept can be adopted in ordering delivery from excessive food stock or presenting amount of reduction in food waste and greenhouse gases emission and of nearly expired quality food products donated to those in need by using application to trace the donation. Including affixing yellow labels on products that are nearing their expiration date and showing the amount of greenhouse gas reduction that buyers can help reduce.

From above mentioned examples, changing behavior to reduce food waste can be simple and only requires planning in preparation of meals and having better understanding on consumer demand. Communicating with the consumers and proving them with more information can effectively prevent turning meals into food waste. It should, however, be constantly reminded that designs for specific target groups require understanding on when and where their behaviors manifest and on origins of the behaviors themselves since they are of critical importance in identifying options and setting environments for behavioral change. It is also necessary to make the desirable outcome a better choice to current behavior or to make the undesirable outcome less attractive.

## 2.4 Opportunity analysis to adopt technology for food waste management

The analysis adopted a recognizable and widely used concept developed by WRAP (2018)<sup>2</sup> for management of food waste. The concept divides the management into 2 parts which are 1) preventing waste generation with diverse means and 2) managing the waste with digestion, composted, waste to energy or in landfills as Figure 2.



**Figure 2** Food and drink material hierarchy developed by Wrap  
Source: WRAP, 2018

<sup>2</sup> WRAP 2018, Food waste measurement principles and resources guide.

Outcomes of surveys, review on case studies and a behavioral economics study on management of food waste can be listed as shown on Table 2. It should note that some actions were taken with adoption of technology while others were without involvement of any technology.

**Table 2:** Current methods for management of food waste with and without adoption of technology

Preventing food waste generation	Managing the food waste
<b>Overall</b>	
<ul style="list-style-type: none"> <li>- Distributing information to build knowledge and understanding on importance of and impacts from food waste.</li> </ul>	<ul style="list-style-type: none"> <li>- Conducting inventory on quantity and composition of food waste.</li> <li>- Utilizing BMA's compost plants.</li> <li>- Identifying targets and indicators for each district office.</li> </ul>
<b>Distribution</b>	
<ul style="list-style-type: none"> <li>- Announcing policies and targets on reduction of food waste*.</li> <li>- Employing systems to check and manage stocks.</li> <li>- Planning for purchase of ingredients.</li> <li>- Developing coating from natural extracts to extend shelf-life of fruits and vegetable by 5 times.</li> <li>- Networking donation of excess food.</li> </ul>	<ul style="list-style-type: none"> <li>- Encouraging sellers and buyers to engage in waste segregation*</li> <li>- Recording and reporting on food waste for data centers or headquarters.</li> <li>- Utilizing machines that turn food waste into compost within 24 hours.</li> <li>- Employing biogas generation systems.</li> <li>- Composting.</li> <li>- Producing bio-agents.</li> <li>- Using coconut coir and shell (endocarp) for planting.</li> </ul>
<b>Service</b>	
<ul style="list-style-type: none"> <li>- Employing an application to record food wastes and analyze cause, trend and cost of food lost.</li> <li>- Employing systems to check and manage stocks.</li> <li>- Planning for purchase of ingredients.</li> <li>- Carrying out organic farming to produce ingredients and use fertilizer made from food waste*.</li> <li>- Conducting behavioral analysis on seller and buyers*.</li> <li>- Making then youth realize importance of food and of not leaving any leftover*.</li> <li>- Campaigning for appropriate serving in any food order*.</li> <li>- Adding diverse items in menu*.</li> <li>- Using poorly shape ingredients in cooking*.</li> <li>- Preparing meals with discarded ingredients*.</li> <li>- Building relevant knowledge and understanding among chefs*.</li> </ul>	<ul style="list-style-type: none"> <li>- Providing food waste bins.</li> <li>- Setting up system for segregating food waste.</li> <li>- Rewarding sellers who segregate food waste*.</li> <li>- Adopting Nudge in designing and testing measures to change behaviors on food waste segregation*.</li> <li>- Farming earth worms.</li> <li>- Utilizing machines that turn food waste into compost within 24 hours.</li> <li>- Employing biogas generation systems.</li> <li>- Composting</li> <li>- Producing bio-agents.</li> <li>- Using food waste as animal feeds (by farmers) *.</li> <li>- Using coconut coir and shell (endocarp) for planting.</li> </ul>

Preventing food waste generation	Managing the food waste
<ul style="list-style-type: none"> <li>- Networking donation of excess food.</li> <li>- Organizing systems to distribute excess food to the underprivileged and other relevant public services.</li> <li>- Arranging logistics for distribution of excess food.</li> <li>- Recording donation and distribution of excess food and reporting to donors.</li> <li>- Preserving food at appropriate temperature.</li> <li>- Employing an application for purchasing excess or nearly expired food and informing the users on how much they contribute to mitigation of greenhouse gases emission (by using the application).</li> <li>- Employing an application to reward not having leftover.</li> <li>- Adopting Nudge in designing and testing measures to change behaviors on food waste segregation*.</li> </ul>	
Household	-
<ul style="list-style-type: none"> <li>- Planning or making checklists before purchasing*.</li> <li>- Ensuring appropriate storage.</li> <li>- Being more articulate in preparing meals*.</li> <li>- Not leaving any leftover*.</li> <li>- Processing unused ingredients and leftover.</li> </ul>	<ul style="list-style-type: none"> <li>- Communicating with households on segregating food waste.</li> <li>- Providing fermentation bins for food waste.</li> <li>- Composting</li> <li>- Utilizing machines that turn food waste into compost within 24 hours.</li> <li>- Producing bio-agents.</li> <li>- Using food waste as animal feeds*.</li> </ul>

**Note:** \* Actions taken without adoption of any technology

Diverse arrays of technology for food waste management can be adopted in accordance to circumstance of each area, requirements of organizations/agencies and needs of target groups. Aspects of the adoption can be listed as follow;

- 1) **Communication technology:** Technology can be used to distribute information through multiple channels to various target groups. The information includes importance of food, impacts from food waste and utilization of food waste. The technology can also be used to campaign against leftover and for segregation of food waste.
- 2) **Information technology:** Information technology can be used to record and analyze quantity and composition of food waste as well as identify origins, trend and cause of the waste. Such technology could assist in addressing food waste problems at agency and establishment level as well as for the whole area of Bangkok.
- 3) **Inventory control and stock management technology:** Technology was adopted in managing stocks of large and small food distributors including hotels, restaurants and other food outlets. Such technology was developed at their headquarters or by owners of franchises while small

firms were found to acquire the technology by purchasing (i.e. licensed software). The technology is generally used in checking stocks, identifying products with nearly expired date, assessing popularity of products, pointing out seasonal demand (of consumers) and verifying any withdraw and restocking. Technology usually enables linkage with accounting to reflect on daily revenue and expense.

- 4) **Food preserving technology:** Refrigeration technology is commonly used for food preservation while an innovation of coating made from natural extracts was introduced to extend shelf-life. Attempts have been made to develop packaging that prolongs preservation and the First in – First out concept for shelving in retailers and households was adopted to reduce amount of food with expired date.
- 5) **Technology for logistics mangement:** Technology plays a major role in food distribution ranging from enabling distribution centers, development of packaging that reduce damage from impact, planning for transportation service, identifying transport route for distribution of excess food to arranging for cost and time saving route to collect and transport food waste (for feeding animal or turning into compost).
- 6) **Digestion and composting technology:** Advancement in technology includes introduction of machines that turn food waste into compost within 24 hours. The despite their high price, the machines come in different sizes for both households and industries and can dispose food waste on daily basis. Other notable technologies include biogases generation systems which are suitable for establishments where food waste is mostly comprise of carbohydrate and the waste composition remains relative stable from day to day. Disposal of food waste can build on pre-existing knowledge such as earth worm farming, composting, making bio-agents and recycling.
- 7) **Online application:** Digital technology enables interactive communication in real-time under relatively stable platform providing that concise objectives are identified, design and development are consistent with the objectives, testing is sufficient and monitoring and assessment are effectives. Online applications can record and analyze food waste and enable purchase of excess and nearly expired food products.

Nevertheless, **technology should be adopted with other methodologies**, particularly in building awareness, changing attitudes and behaviors, creating incentives and forging cooperation among owners and operators of hotels, restaurants, food courts and catering services. Nudge Theory can be adopted in designing and testing measures to change behaviors of each target group.

### 3. POLICY RECOMMENDATIONS ON FOOD WASTE MANAGEMENT IN BANGKOK

*This section aims to facilitate national and local policymakers to announce commitments and specific actions that are supported by 'green technologies' to reduce wastes in the food supply chain in Bangkok; assisting businesses to incorporate these technologies into their operations; and supporting local communities to tackle the waste problem.*

Food waste in Bangkok is largely originated from food and service providers and households. Management of food waste is carried out by the BMA in accordance to the second phase (2018-2022) of the 20-year Plan for Bangkok Development. In addition to ensuring interoperability with other relevant administrative measures, the Plan took into account local conditions and requirements as well as waste management capacity of the city. Management of food waste in Bangkok is also carried by other relevant state agencies, private sector, education institutes and NGOs.

Pre-existing projects and activities were found to focus on disposal of food waste such as promoting the use of fertilization bins to dispose food waste (due to limited space available in densely populated communities of Bangkok). A number of actions were taken to segregate food waste for feeding animals, composting and making bio-agents while activities to reduce food waste in establishments included distribution of excess food, online purchasing of excess food and research and development of food preservation. Various parties were found to become more aware of the issue, providing an opportunity to elevate and expand the management actions in light of good practices on food waste reduction and disposal.

From the above problems causing food waste from various sources, either from food distribution sources, service sources, and households in Bangkok. Key drivers can be analyzed using the STEEP framework as S-social; T-technology; E-environment; E-economic; and P-policy that enables comprehensive analysis, and can be summarized as follows:

- **Ignorance of relevant sectors;** both the business owners and employees, as well as family members which play a role in planning of food procurement to have the quantity and type that are suitable for distribution or daily consumption. In addition, sorting and storing of food in order to reduce food residues as well as the problem related to consumers' purchasing behavior that cause damage to the products and over-taking of food for consumption. In addition, most people dispose of food waste with other waste. As a result, the waste disposal by the composting plant in Bangkok has low efficiency.
- **Lack of information and proper alternatives;** although there are some good examples of how to prevent and use food waste, but it's also a tricky method for urban households. Lack of communicating those examples to understand the advantages and limitations, and no food waste disposal guideline for different types of sources are among the gaps identified. Although some of the collected food waste is used to compost and feed the animals.
- **Lack of data on environmental impact;** the fact that businesses and households are disposing of food waste together with general waste. After that, BMA collects and transports most of the food waste to landfills. The waste producers do not directly face the problem of

bad odors or the effects of waste, makes it overlooked that transporting waste to landfill uses energy and emits greenhouse gases.

- ***Economic and competitive conditions;*** affect consumer purchasing power and tourism growth. As a result, the amount of waste in the past tends increased steadily which is consistent with economic growth. Until 2019 onwards, there has been COVID-19 pandemic in various areas, with lockdown measures undertaken, the businesses had to close, no tourists come in, and economic slowdown. Some of Bangkok people also returned to their homeland. This situation has resulted in the waste including food waste in Bangkok, is clearly reduced.
- ***Local policies and practices are unclear;*** although Thailand has announced its intention to achieve the Sustainable Development Goals (SDG), which has the goal of reducing food waste in target 12.3 and has relevant national policies to focus on reducing food waste at the source. But there is still a lack of policy transferring to the local level, including no clear guidelines. Although, there is a promotion to use organic waste composting bins in the households, but there are also restrictions for urban housing and urban lifestyles which has limited space and time.

### **Policy recommendations for food waste management in Bagkok**

The following policy advices are to be presented to the BMA and other relevant agencies with the view to fill the gaps and build capacity in management of food waste as well as enable behavioral change in various target groups and increase opportunity for adoption of technology.

#### **1. Adopting relevant national plans into BMA actionsy**

Policy makers should enable adoption of their policies and plans into actions that can be carried under the existing operational framework of the BMA. This should be accompanied by an inventory and an information system on food waste and efforts should be made to ensure their interoperability with national and international systems of relevance. Action plans should be formulated and measurable targeted should be identified for reduction of food waste with the view to prevent and minimize waste generation, enable systematic waste segregation and collection and provide appropriate guidance for waste disposal.

#### **2. Public communication and proactive delivery of information**

Public relation and environmental promotion agencies should continuously communicate with the public on 4 majors' issues related to food lost and food waste. These are 1) food information including food quality, origins and labeling (expire date), 2) food waste including its quantity and impacts as well as cost for its disposal, 3) measures and methods for reducing food waste where public participation can contribute to prevention of waste generation and utilization of food waste and 4) interesting or inspiring case studies.

#### **3. Changing consumer behaviors**

The BMA should cooperate with institutes of technical excellence to provide appropriate education to children, build consumer awareness among working populations, particularly the higher income groups, and enable participation of housewives who are responsible for preparing meals. The aims for such engagement would be to present methods and options to reduce food waste by taking into account social limitation of Bangkok, to provide information on impacts of food waste on the

environment, climate change and general wellbeing of residents and to adopt Nudge Theory for behavioral change.

#### **4. Incentive measures and waste reduction and segregation**

The BMA should adopt provisions to create incentives for waste reduction and segregation in establishments, communities and housing complexes. By meeting certain conditions, participants could receive discounts on annual fee for food distribution and storage facility and on waste disposal charges for communities and condominiums. Conditions for controlling disposal of food waste from major contributors could be identified and tested in order to develop them into legal-binding provisions.

#### **5. Accelerating development of systems for utilization of food waste**

The BMA should develop a concise system that enable utilization of a large amount of food waste. This can be carried out with campaigning or directives for segregation, collection and transportation of food waste in order to build confidence and cooperation of the public on segregation of food waste. The system for utilization of food waste should increase effectiveness of composting and raise disposal capacity and a study should be carried out to determine appropriate size and technology for waste distribution in Bangkok.

#### **5. Increasing the role of private sector**

Policy makers and implementing agencies should build cooperation with private sector through The Federation of Thai Industries, Thai Chamber of Commerce and associations involved in food production, retailing, distribution and service in order to increase roles of the private sector in developing action plans, distributing responsibilities and resources and widening scope of engagement with business operators on reduction of food waste in Bangkok, industrial areas and other major cities.

#### **7. Supporting research and development on technology and innovation**

National research agencies should promote development of communication technology and online applications that enable learning and connection between relevant business operators and sectors. Supports should be provided for development of food packaging, food preservation, utilization of food waste and convenient methods for more economical disposal of food waste at household, business and local levels.

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## Annex

### Roles of the key stakeholders on food waste management in Bangkok

Organization	Project/Activity
<b>Government sector</b>	
<ul style="list-style-type: none"> <li>• Office of Natural Resources and Environmental Policy and Planning (ONEP)</li> </ul>	<ul style="list-style-type: none"> <li>- Produced the Sustainable Consumption and Production Roadmap, 2017-2036.</li> <li>- Studied and formulated appropriate food waste management guidelines for each sector and prepared policy recommendations for relevant agencies.</li> </ul>
<ul style="list-style-type: none"> <li>• The Pollution Control Department (PCD)</li> </ul>	<ul style="list-style-type: none"> <li>- In the process of preparing the roadmap to manage the country's food waste.</li> <li>- In the process of preparing a 5-years food waste management action plan.</li> <li>- In the process of surveying the amount of country's food waste.</li> </ul>
<ul style="list-style-type: none"> <li>• Environment Department, BMA</li> </ul>	<ul style="list-style-type: none"> <li>- Determined indicators for district offices in order to use the solid waste.</li> <li>- Promotes community-based waste management in pilot communities</li> <li>- Manages composting plant containing 1,600 tons of food waste per day.</li> <li>- Cooperates with Central Department Store - Rama 3. In collecting food waste and making compost.</li> </ul>
<ul style="list-style-type: none"> <li>• District Office, BMA</li> </ul>	<ul style="list-style-type: none"> <li>- Collects fruit and vegetable scraps from the fresh markets to make compost and bio-fermentation.</li> </ul>
<ul style="list-style-type: none"> <li>• Thai Health Promotion Foundation (ThaiHealth)</li> </ul>	<ul style="list-style-type: none"> <li>- Studied the guidelines for managing surplus food.</li> </ul>
<ul style="list-style-type: none"> <li>• National Science and Technology Development Agency (NSTDA)</li> </ul>	<ul style="list-style-type: none"> <li>- Developed the Lookie Waste application to monitor food waste and food packaging.</li> <li>- Developed a handbook to survey the amount of food waste and food waste reduction guidelines.</li> </ul>
<ul style="list-style-type: none"> <li>• Office of National Higher Education Science Research and Innovation Policy Council (NXPO)</li> </ul>	<ul style="list-style-type: none"> <li>- Allocates budgets to support research on food waste under the circular economy program.</li> </ul>
<ul style="list-style-type: none"> <li>• The Market Organization (MO)</li> </ul>	<ul style="list-style-type: none"> <li>- The Go Green Plus project has waste management criteria.</li> </ul>
<ul style="list-style-type: none"> <li>• Department of Health (DOH)</li> </ul>	<ul style="list-style-type: none"> <li>- The assessment of the worth buying fresh market (Talad-Sot-Na-Seu) project which has criteria for segregating wastes into wet waste and dry waste.</li> </ul>
<ul style="list-style-type: none"> <li>• Office of Bangkok Metropolitan Administration Market</li> </ul>	<ul style="list-style-type: none"> <li>- There is no clear data on food waste activities.</li> </ul>

Organization	Project/Activity
• Department of Tourism (DOT)	- There is no clear data on food waste activities.
• Department of Environmental Quality Promotion (DEQP)	- Awareness raising using infographics - The Green Restaurant project has criteria for reducing and managing food waste. - Promote the zero waste communities and zero waste schools.
• Thailand Convention and Exhibition Bureau (TCEB)	- Project to reduce food waste from food services with large hotels. - Connects surplus food donations between hotels with SOS Foundation.
• General government agencies	- Selects procurement or service providers with certified environmental friendly performance.
• Department of Education, BMA	- Supports schools under its management to reduce and segregate food waste.
• Social Development Department, BMA	- Supports pilot communities to make compost and bio-fermented water.
• National Housing Authority (NHA)	- There is no clear data on food waste activities.
<b>Private Sector</b>	
• The Thai Chamber of Commerce (TCC)	- Declared a mission to reduce food waste in commerce and service sectors, and promotes the use of surplus food to donate to the people in need.
• Thai Retailer Association (TRA)	- There is no clear data on food waste activities.
• Thai Fresh Market Association	- There is no clear data on food waste activities.
• Hypermarket/ Supermarket	- Promote selling and reduction of unsold products. - Lotus supermarket donates damaged packaging products and other type of products which will be expired in 2 months to the SOS Foundation.
• Convenience Store	- TOPs and Family Marts donate surplus food to the SOS Foundation.
• Market	- Thanom Mirt Market, Sriyan Market, Bangkapi Fresh Market, Ying Charoen Market have a system to segregate and manage food waste.
• Thai Hotels Association (THA)	- There is no clear data on food waste activities.
• Hotels	- Hotels in Centara Group manage food waste and surplus food to donate to SOS Foundation. - Ten high end hotels join a project on food waste management with สส.ปณ.
• Restaurant	- Mulika restaurant, and Sizzler have the procedure to reduce and use their food waste. - Several restaurants set targets and alternatives to reduce food waste.

Organization	Project/Activity
• Food court	- Don Meung International Airport segregates food waste from the food shops and collects for Don Meung District Office to distribute to the fish farms.
• Catering service	- Keaw Keaw case for catering service that minimize food waste
• Residential Juristic Person	- There is no clear data on food waste activities.
• Housing estate	- There is no clear data on food waste activities.
• private company	- CP Ram organized a competition for VDO clips to raise awareness and educate on food waste.
<b>People and other sectors</b>	
• Academia institute	- Chula Zero Waste to segregate waste and use food waste to make compost. - Some schools raise awareness to the students to clearly tell the food vendors of the amount of food they want, as well as segregate and collect food waste to farmers.
• Research institute	- Mahidol University, Kasetsart University produced some research on food waste. - King Mongkut's University of Technology conducted research and development on plant-based plastic 'HERO' and can be 100% biodegradable.
• Mass media	- Disseminate information
• NGOs	- SOS Foundation accepts donations and distribute surplus food to the people - Thailand Environment Institute (TEI) studies and promotes on food waste issues
• Care homes for the underprivileged	- Receives surplus food
• Service users	- Chose to use service providers with environmental friendly practice and manage food waste
• Temple	- Don Meung Temple collects food from people who make merit to donate for others.