

Applying the Circular Economy Model to Urban Waste Management in Singapore and Experiences for Vietnam

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Abstract

In order to effectively implement the circular economy model, we need to address the core issue of waste management. This is the step to put the waste back into the cycle instead of disposing in the traditional way. As the world economy is rapidly growing, many aspects may pose as challenges, especially urbanization, industrialization, and population growth, and urban waste treatment. Poor management of urban waste can cause many consequences for the environment, people's health and thus affect the whole economy. Therefore, urban waste management according to the circular economy model is an important step. Indeed, it requires close attention and proper implementation to be able to complete the circular cycle of the economy while also effectively solving the problem of urban waste. This paper studies the theoretical foundations for assessing the practicality of urban waste management based on the circular economy model in Singapore, through analyzing the current conditions of Vietnam. This paper collects and analyzes relevant documents and data to synthesize and evaluate the actual situations in Singapore and Vietnam. The objective is to provide lessons for Vietnam in constructing the effective management of urban waste according to the circular economy model.

Research purpose:

This paper initially analyzes the impact of the circular economy model in the specific context of urban waste management in Singapore and Vietnam. In particular, the way that Singapore is applying urban waste management can provide a lesson for Vietnam - a neighboring Southeast Asian country. Although Vietnam is applying four methods to manage waste, they are not effective and have many shortcomings. Learning from Singapore will help Vietnam's urban waste management become more efficient, superior and leaner. Towards the goal of providing solutions for policymakers on possible measures to effectively make changes to the urban waste management in Vietnam.

Research motivation:

There are many lessons we can derive by studying Singapore's urban waste management experience. Although rapid growth and industrialization are good signals for Vietnam's development, they also have many negative impacts on the environment and natural resources. The unsustainable exploitation of natural resources of the linear economy has been causing many consequences for the sustainable development of the country. To solve these problems in the long term, the traditional linear economic model needs to be replaced by a circular economy model, especially in the management and treatment of urban waste. Therefore, studying and adopting experiences in urban waste management from Singapore in a timely manner is the key for Vietnam to solve this existing problem.

Research design, approach and method:

This paper uses the theoretical foundation to assessing the practicality of urban waste management based on the circular economy model in Singapore, through analyzing the current conditions of Vietnam. By collecting and analyzing documents and related data to synthesize to assess the actual situation in Singapore and Vietnam, the paper proposes some lessons for Vietnam to effectively manage urban waste according to the circular economy model. This paper is conducted to collect and analyze information and data on urban waste management in the period of 2016-2020 in Singapore and Vietnam.

Main findings:

Applying a circular economy model to urban waste treatment helps reduce input costs as it is possible to make the most of waste sources, while reducing the amount of waste disposal. This paper clearly shows that Vietnam needs to develop transparent mechanisms and policies in the treatment of urban waste. Besides, Vietnam also needs to strengthen financial resources to provide enough capital, infrastructure and facilitate the development of new technologies. In

addition, raising public awareness about urban waste treatment is also extremely necessary to coordinate between people and effectively apply reduce - recycle – reuse procedures.

Practical/managerial implications:

From the analysis of factors related to the waste treatment experiences of Singapore and Vietnam, this paper has proposed several solutions on mechanisms and policies to increase the efficiency of urban waste treatment, thereby building a circular economy model. In practice, the government needs to take measures to regularly check and study all the policies it has put in place to make timely adjustments and ensure effective implementation. Moreover, urban waste management needs to be carried out in the direction of socialization. Therefore, it needs to be widely propagated on the mass media and social networking platforms in Vietnam.

Keywords: Circular economy model, urban waste management, Singapore, Vietnam.

1. INTRODUCTION

Currently, along with the continuous development of the economy, the process of urbanization, industrialization and population growth, natural resources are in danger of being depleted due to exploitation, over-use without being regenerated, the environment is polluted, climate change takes place fiercely. Therefore, the circular economy model was born and became a global trend to solve the challenges of resource depletion, environmental pollution, climate change, and at the same time improve economic efficiency (Goyal et al., 2018). The circular economy model is not only about reuse of waste, considering waste as a resource, but also connecting production, consumption, and disposal to create a circular cycle in the economy (Jing et al., 2018). Thus, it helps to make use of used materials, avoid wasting resources, and limit waste into the environment. Among many countries that do well in urban waste management such as the UK, the US, and Sweden, Singapore stands out as a young country in Southeast Asia that is extremely effective in implementing the problem on urban waste management (Zhang et al., 2010). Singapore can be considered as a model for Asian countries in general and Southeast Asian countries like Vietnam in particular to learn from experience.

Singapore is a small island country in Southeast Asia with an area of 728 square kilometers, including 64 large and small islands (Deuskar et al., 2015). According to Carrière et al. (2020), this country has a small population, no natural resources, but a favorable geographical position for sea and air traffic in the region. When it was first established, Singapore was a poor country, but thanks to the strong decisions of the government in promoting industrialization, attracting foreign investment, reducing inflation, and improving people's living standards. Currently, Singapore has risen to become the Asian "dragon" of economic growth (Patil et al., 2021). Singapore's environment is considered the cleanest and greenest in the world, even though the country is already 100% urbanized (Sim et al., 2020). Singapore has almost no resources, raw materials must be imported from outside. Therefore, this country must import food every year to meet domestic demand. Singapore has infrastructure and some of the most highly developed industries in Asia and the world such as seaports, shipbuilding and repair industry, oil refining industry, processing, electronics, and fine machinery assembly (Deuskar et al., 2015). Singapore has 12 major industrial zones, the largest of which is Jurong Industrial Park (Wong et al., 2021). Singapore is a leading country in the production of electronic computer drives and semiconductors. Singapore is also a leading oil refining and transit hub in Asia. In addition, the tourism of this country is also very developed.

Table 1: Volume of municipal waste generated in Singapore (2016-2020)

(Unit: Thousand tons)

Year	2016	2017	2018	2019	2020
Volume	7.814	7.704	7.695	7.234	5.880

Source: Singapore National Environment Agency (NEA), 2021.

Singapore's growing population and booming economy contributed to an increase in urban waste in Singapore between 2000-2016. In 2000, the amount of municipal waste generated in this country was more than 4.6 million tons and by 2016 it had increased to more than 7.8 million tons. However, since 2016, the total amount of urban waste tends to decrease. In 2020, only about 5.88 million tons of urban waste will be generated, down 19% compared to 2019. There are two main reasons for this drop. First, the Covid-19 pandemic impacted to waste generation and recyclables collection in 2020. Because of the Circuit Breaker, people had to work, studied, and ate at home then demand for goods and services fell leads to a decline of waste generation. Although households disposed of more packaging waste, as online shopping and home-delivered food gained market share during Circuit Breaker, recyclables collection programmers (e.g., Cash-for-Trash, door-to-door collection, ad-hoc collection drives with schools and Residents' Committee centers) under the Public Waste Collectors (PWCs) were halted. Second reason is Singapore does good management of urban waste according to the circular economy model. Despite many difficulties in waste treatment due to geographical characteristics, in order to save land area and reduce the amount of waste to be landfilled (Patil et al., 2021), Singapore has implemented many measures such as (1) investing in waste incineration technology electricity generation; (2) strengthen the segregation of waste at source; (3) heavy fines for acts of causing environmental pollution; (4) promote recycling of waste; (5) propagate to the people about environmental protection; etc. (Pearce and Chertow, 2017). Singapore not only reduced the amount of waste but also successfully recycled a large amount of urban waste, while continuing to manage the remaining waste by burning to generate electricity and only a small amount of waste after burning, which cannot be treated, will be buried in an environmentally friendly garbage island, and attract tourists (Wong et al., 2021).

Vietnam is one of the fastest growing economies in Southeast Asia as well as in the world (Hai et al., 2021). After the reform process in 1986, Vietnam's economy has made remarkable developments, from one of the poorest countries in the world to a low-middle-income country. Although rapid growth and industrialization is a

good sign for Vietnam's development, it also leaves many negative impacts on the environment and natural resources. The unsustainable exploitation of natural resources of the linear economy has been causing many consequences for the sustainable development of the country. Besides, Vietnam has also been experiencing rapid changes in population and social structure. According to the World Bank, in 2019, Vietnam's population reached 96.5 million people, an increase of more than 60% compared to 60 million people in 1986. In which, the proportion of urban population also increased from 19.6% to 36.6% in 2016 and 2019 respectively. In the current economic context, urbanization, economic growth, and rapid population growth are posing increasing environmental challenges (Hoang and Fogarassy, 2020). To solve these problems in the long term, the traditional linear economic model needs to be quickly replaced by a circular economy model, especially in the management and treatment of urban waste. According to the National State of Environment Report (2019) of the Ministry of Natural Resources and Environment, in 2011, the total volume of waste generated nationwide was about 44,400 tons per day. By 2019, this figure is 64,658 tons per day, an increase of 46% compared to 2010. Localities with a volume of urban waste generated over 1,000 tons per day account for 25%. Thus, the amount of urban waste generated in Vietnam is quite large and still tends to increase year by year, urban waste has been having great impacts, not only on the environment and society but also in economics (Hoo et al., 2020). The ineffective control and management of urban waste also causes many impacts on public health as well as potential conflicts in the areas around the waste management facility. In addition, urban waste can also be "garbage" in the old economic model but can also become a "resource" if used and managed well when included in the circular economy model (Hai et al., 2020). Therefore, studying and absorbing experiences in urban waste management from Singapore is the key for Vietnam to solve this existing problem and needs to be handled quickly and in a timely manner.

2. WHAT IS CIRCULAR ECONOMY MODEL?

2.1 The concept of circular economy model

In the context of the growing economy, natural resources are continuously exploited along with the increase of waste, leading to negative impacts on the environment. To overcome this problem, the circular economy model was born and gradually became the inevitable development trend of the world (Goyal et al., 2020; Ionascu et al., 2018; Chen et al., 2020; Mathews and Tan, 2016). However, the concept of circular economy is often approached and defined in different ways in each country to suit the situation of each region.

The concept of a circular economy was first used formally by Pearce & Turner (1990), to refer to a new economic model based on the basic principle that

"everything is an input to another", completely different from the view of the traditional linear economy.

On the other hand, the concept of a circular economy is presented in contrast to the linear economy - the traditional economic model that has been operating for hundreds of years. Linear economy is a way of economic development following a straight-line model, from resource extraction as input for production to distribution, consumption and finally disposal (Figure 2.1). Therefore, the linear economic development will accelerate the process of resource exploitation and waste generation, leading to resource depletion and environmental pollution (Kuo and Chang, 2021). In contrast, the circular economy is geared towards connecting the end of that line back to the beginning, becoming a closed cycle to keep matter in use for as long as possible. In the same view, according to the United Nations Industrial Development Organization (UNIDO) in 2017, the circular economy is a closed production cycle, wastes are returned, becoming raw materials for production. As a result, it helps to reduce any negative impact on the environment, ecosystem, and human health.

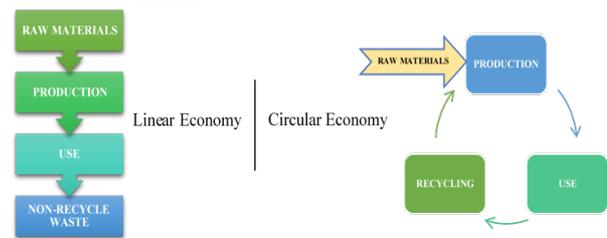


Fig 2.1: Linear economy and Circular economy

Source: Ellen MacArthur Foundation, 2012.

According to Vietnam's Law on Environmental Protection 2020, circular economy is an economic model in which design, production, consumption and service activities reduce the exploitation of raw materials, and prolong the product life cycle, limit waste generation and minimize adverse impacts on the environment. Consequently, the circular economy can be understood as a system that restores and regenerates through prolonging the life of products, increasing the productivity of resources (Whalen and Whalen, 2020; Wu et al., 2021). All "waste" of a consumer production process should be treated as raw material for other consumer production processes, and regardless of whether it is a by-product, resource recovered from another industrial process (Wu et al., 2021; Rathore and Sarmah, 2020) or a resource regenerated for the natural environment (Jing et al., 2021).

2.2 The role of the circular economy

For the macro economy, Mathews and Tan (2016) state that the circular economy contributes to macroeconomic growth and saves costs for the overall economy through the efficient use of resources and input materials, while promoting promote innovation activities. Indeed, Patwa et al. (2021) argue that in the circular economy model,

input materials taken from wastes of production and consumption activities have a much lower cost than new materials, thus saving production costs. The development of new technologies and ways of operation also helps to improve production efficiency. From these positive changes, the economy has good changes in productivity, supply, demand, and product prices for economic growth (Rathore and Sarmah, 2020).

For the micro-economy, Mathews and Tan (2016) also describe that the circular economy for businesses contributes to increasing profits, overcoming resource depletion, prioritizing investment, technological innovation, reducing production costs, increasing supply chains, and prolong the product life cycle, etc. When the dependence of production materials on natural resources is reduced, enterprises will have increased security for the supply of raw materials. This avoids supply shortages or price fluctuations due to natural disasters and political instability (Whalen and Whalen, 2020). Besides, the utilization of waste materials helps to save production costs, thereby increasing profits for enterprises. In addition, the circular economy also helps to increase new demand for new supply chains and business services such as the collection of products that are considered to be at the end of life to continue to enter the new production cycle (Chen et al., 2020). As a result, it helps to extend the product life cycle or recycle and trade those products.

For consumers, the circular economy helps reduce the cost of purchasing new equipment, increase disposable income, and increase convenience for consumer products (Chen et al., 2020). When manufacturers can reduce production costs and products have been optimized for use and reuse, consumers will be able to reduce consumption costs (Ghomi et al., 2021), thereby increasing disposable income. Extending product life cycles and technological innovations in the circular economy also provide consumers with the opportunity to use products that can last a long time, increasing levels of recycling and reuse (Goyal et al., 2018).

For society, the circular economy helps to (1) reduce the social costs of environmental management; (2) respond to climate change, contribute to environmental protection; (3) create new markets, new job opportunities for workers; improve the health and quality of life for the people (Whalen and Whalen, 2020; Hoo et al., 2020; Ionascu et al., 2018). When waste is fully utilized as the next raw material for the production process, entering the cycle with a strict process and avoids wasting "resources of waste", the amount of waste discharged into the environment needs to be reduced gradually. Thereby, the cost of waste management of society is also reduced. In the context of climate change that has been and is affecting the whole world, the circular economy model helps to reduce the consumption of raw materials in daily life and production (Ionascu et al., 2018; Jing et al., 2021). At that time, natural resources are no longer under great pressure like when they were in a linear economy,

avoiding resource depletion and increasing the resilience of the ecosystem. Besides, prolonging product life cycle helps to reduce the need to produce new products, old products are used longer and then continue to be used as raw materials, reducing waste into the environment, as well as reduce greenhouse gas emissions and enhance soil quality to protect the environment (Rathore and Sarmah, 2020).

In addition, the circular economy model with increased innovation in business services, new supply chains, especially the waste industry will create a diversity of job opportunities in many fields (Jing et al., 2018; Mathews and Tan, 2016). Moreover, people's living conditions are also improved when they live in a stable economy and a cleaner, greener living environment. Thus, the circular economy model not only helps economic development but also protects the environment, bringing a lot of benefits to the whole society (Patwa et al., 2021).

2.3 Principles of operation and classification of levels of the circular economy

The circular economy is an economic system that is restored and regenerated by design based on three key operating principles (Chen et al., 2020) including (1) conservation and enhancement of natural capital; (2) optimize resource productivity; (3) promote system efficiency (Goyal et al., 2018; Chen et al., 2020).

Firstly, the circular economy preserves and enhances natural capital. Through controlling the input and output materials in the cycle (Ghomi et al., 2021), especially promoting the use of renewable energy, resources are used rationally and enhancing the regeneration of natural systems. Secondly, the circular economy optimizes resource productivity by circulating products and materials as much as possible in engineering and biological cycles (Hoo et al., 2020). Thirdly, the circular economy promotes system efficiency by minimizing negative economic externalities to the environment through waste and pollution design from the outset of the production process (Kuo and Chang, 2021).

In addition, the circular economy is divided into three levels of access (Kuo and Chang, 2021; Jing et al., 2021). At a low level, the circular economy focuses on the production process of businesses and the production of agricultural products, producers are encouraged and required the adoption of cleaner production methods and ecological design. At the medium level, the circular economy includes the development of eco-industrial parks and other agro-ecological systems. Designing to give your business the best chance of implementing a circular economy. At a high level, all stages of the production process are designed, with no waste released into the environment. Waste is reduced to a minimum and reused (Chen et al., 2020).

3. APPLYING THE CIRCULAR ECONOMY MODEL TO URBAN WASTE MANAGEMENT

3.1 Urban waste concept

In each country, the concept of waste, waste has many differences (Aleluia and Ferrão, 2016; Wu et al., 2021; Zhang et al., 2010; Rathore and Sarmah, 2020; Goyal et al., 2018). In this study, the concept of urban waste is used as the concept of urban or municipal solid waste or domestic solid waste. In Vietnam, there is no definition of “urban solid waste” in waste-related legal documents, but only “domestic solid waste”. However, many countries around the world often use the term municipal solid waste to represent domestic solid waste and each country has its own definition or concept for municipal solid waste (Schneider et al., 2017; Zhang et al., 2010; Wong et al., 2021).

According to Vietnam's Law on Environmental Protection 2020, waste is defined as matter in solid, liquid, gaseous or other forms discharged from production, business, service, daily life or other activities. Solid waste is waste in solid form or sludge. The general concept given for domestic solid waste (understood as urban waste in this article) is all solid waste generated from urban areas (households, offices and commercial areas, etc.) and excludes waste generated from industrial, construction, and agricultural processes (JWNET, 2018; Pichtel, 2014).

Sources and composition of urban waste

According to Thai (2014) and Aleluia and Ferrão (2016), urban waste is generated from the following 06 sources containing (1) Households; (2) Commercial area (restaurant, hotel, supermarket, market, ...); (3) Offices (agencies, schools, centers, research institutes, hospitals,...); (4) Public areas (stations, piers, airports, parks, amusement parks, streets,...); (5) Public services (street sweeping, parks, entertainment areas,...); (6) Activities of production facilities. It can be seen that the composition of urban waste is very diverse, including mainly food waste, paper, paperboard, fabric, rubber, garden waste, wood, metal, glass, hazardous waste, etc. Besides, the composition of urban waste differs between countries and regions and depends on economic conditions, consumption habits and people's lifestyles (Patil et al., 2021).

In some Asia countries such as China, India and Thailand, urban waste has a very high composition of food and garden waste, therefore often have high humidity and low calorific value according to Table 3.1. For developed countries such as Japan, Korea, Germany, and the United States, urban waste is concentrated in recyclable materials such as paper and plastic. Therefore, this urban waste often has low moisture content and high calorific value, which is an important feature for the selection of urban waste management technology.

Table 3.1: Composition of urban waste in some regions of the world

Element (% wet volume)	China 2016	Bangalore (India) 2018	Bangkok (Thailand) 2014	Korea (landfill) 2005	Singapore 2017	Germany 2016	United State 2017
Food	61,2	81,96	41,10	34,1	39,8	12,1	15,1
Garden waste	1,8	-	6,19		2,3	-	13,3
Paper	9,6	12,69	12,14	27,9	32,2	33,3	25,9
Fabric	3,1	-	4,16	1,9	6,4	-	-
Leather	-	-	-	0,7	0,3	-	-
Rubber	-	-	-	-	0,4	-	-
Fabric, leather, rubber	-	-	-	-	-	-	9,3
Leather and rubber	1,3	-	1,12	-	-	-	-
Plastic	9,8	-	27,31		9,7	24,2	13,1
Wood	-	-	-	1,3	0,8	-	6,2

Metal	1,1	1,67	1,57	1,6	2,0	4,5	9,1
Glass	2,1	0,65	3,42	5,1	0,9	12,1	4,4
Ceramic	1,8	-	0,46	-	0,5	-	-
Bond							
Conch	-	-	1,53	-	-	-	-
Ash	2,5	-	-	-	-	-	-
Others	5,7	3,02	0	12,8	4,7	13,6	3,5

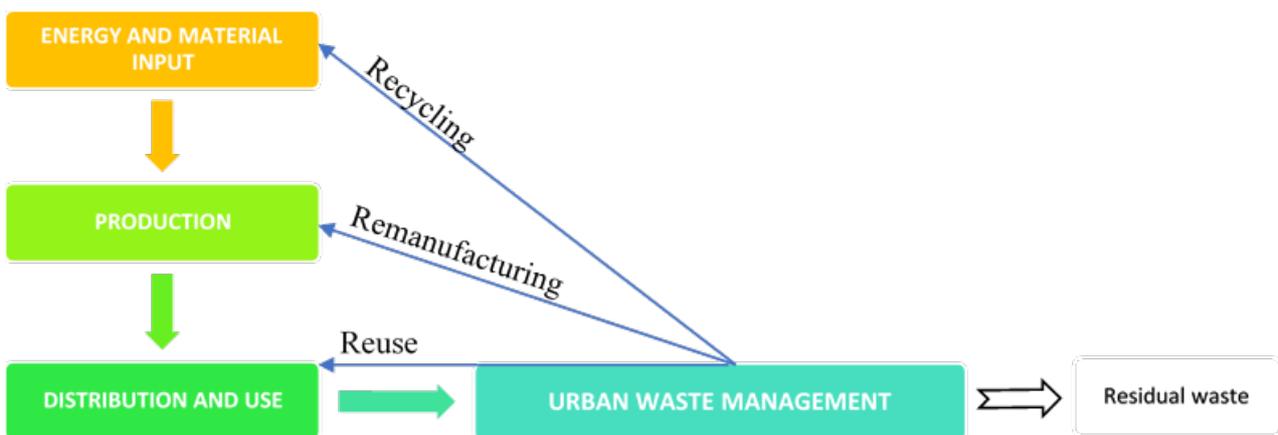
Source: Vietnam Ministry of Natural Resources and Environment, 2019.

3.2 The linkage between urban waste treatment and circular economy model

Urban waste management plays a very important role in the circular economy model (Schneider et al., 2017; Wu et al., 2021; Tsai et al., 2020; Rathoer and Sarmah, 2020; Tong et al., 2021; etc.). This is the decisive step in the cycle, transferring waste from the end of the production or consumption cycle back to the beginning (Aleluia and Ferrão, 2016). Therefore, it determines the success or not of the circular economy model, solving the problem of urban waste management is the key to opening the circular economy and vice versa, the circular economy helps to effectively deal with urban waste.

Firstly, urban waste management is part of a circular economy. The conventional manufacturing economy starts with resource extraction, production, consumption and finally disposal, while the circular economy is geared towards recovery and regeneration to produce other products (Goyal et al., 2018). That way of doing things helps to take advantage of used materials, instead of consuming new resources and waste treatment costs, and avoid creating waste. The circular economy model is proposed in the form of a closed production and

to solve the problem of circular economy is effective waste management. Secondly, the circular economy model promotes effective urban waste management. In the current situation, with increasing population pressure, urbanization and increasing demand for per capita consumption, many resources become scarce, environmental costs of creating new resources or overcoming environmental consequences become a burden on the earth along with the increase of waste, especially urban waste (Wu et al., 2021). Thinking about waste management in the world has changed a lot: from "disposal" to "management" to "integrated management", from "waste" to "regarding waste as a resource", from a "linear economy" to a "circular economy". With innovations in technology and methods, the circular economy has allowed urban waste to be continuously returned to the cycle instead of being disposed. Thus, urban waste management has really become one of the decisive keys to being able to complete the circular economy model. Circular economy can only be solved if urban waste management is well implemented and vice versa, urban waste management will be implemented effectively in a circular economy model (Patil et al., 2021). Effective management of



consumption cycle that helps wastes be "revived" (Biswas and Tortajada, 2021), becoming a raw material for another industry, once again participating in the product life cycle. Therefore, one of the important links

urban waste according to the circular economy model will contribute to building a sustainable society and protecting the environment.

Fig 2.2: The linkage between urban waste treatment and circular economy model

Source: Author's own synthesis (Adapted from Patil et al., 2021; Schneider et al., 2017; Wu et al., 2021; Tsai et al., 2020)

3.3 The method of urban waste treatment

In the world, the management of urban waste according to the circular economy model is urban waste management focusing on waste recycling, focusing on waste segregation at source, reuse, recycling, incineration or landfill (Schneider et al., 2017; Wu et al., 2021; Tsai et al., 2020; Rathore and Sarmah, 2020; Pearce and Chertow, 2017). In general, in order to use urban waste management methods according to the circular economy model, it is necessary to first sort, collect, and transport waste for later management.

Separation of urban waste at source plays an important role in urban waste management, contributing to minimizing the risk of spreading pathogens, toxic and dangerous elements, and contributing to environmental protection (Pearce and Chertow, 2017). In particular, garbage classification is the first step to effectively manage urban waste according to the circular economy model. Proper classification also contributes to saving resources, reducing costs for waste collection and treatment (Wu et al., 2021). Garbage every day before being sent for treatment needs to be classified into three categories including organic waste, inorganic waste and recyclable waste. In addition, Rathore and Sarmah (2020) argue that organic waste is easily degradable and can be recycled to be used as food for animals, as fertilizer for plants. Inorganic waste is waste that can't be used anymore, can't be recycled (brick/stone, broken or useless crockery/ceramic; broken glass, cup, vase; shells of all kinds; shellfish, snails, eggshells; leather goods, rubber goods, broken watches, music tapes, radios, etc.). Recyclable waste is a type of waste that is difficult to decompose but can be recycled for human use (cardboard boxes, old books and newspapers; used paper boxes, envelopes, postcards; assorted soft drink cans, beer cans, tea cans; plastic chairs, brass, plastic pots, old clothes and fabrics, etc.) (Schneider et al., 2017). However, depending on the region, there may be other classifications. Normally, developed countries of the world classify urban waste as waste food ingredients, recyclable ingredients, and leftovers (Ghomi et al., 2021).

Urban waste collection according to the circular economy model needs to be associated with the classification and treatment of waste, waste that is classified into different parts must be properly collected in the right manner in order to be brought for processing (Goyal et al., 2018). There are different forms of municipal waste collection, depending on factors such as geographical location, composition and volume of waste, human resources, and waste management policies. Common forms of collection are collection at public places, collection on sidewalks, collection in residential clusters, collection at home (Hoang and Fogarassy, 2020).

Collection at public places is a form of using common storage locations with large areas as places for

collecting and receiving waste (Wong et al., 2021). On the other hand, sidewalk collection is a form that requires regular collection frequency and precise schedule, for optimal efficiency and convenience. It is the responsibility of the people to put the container in the right place and take back the empty container after the waste has been collected. It is one of the least expensive forms of collection. Another form of collection is cluster collection (Schneider et al., 2017). This is the form in which the collection vehicle stops at the specified locations and people dump waste into the vehicle. Full collection trucks will be transported to a transfer station or treatment facility. Finally, home collection is the form in which the staff collects each household, carries the waste container to the collection vehicle, empties it, and returns it to its original location. This is a form of non-resident participation (Zhang et al., 2010). This method is expensive in terms of labor costs, as it takes a long time for collection at each household. The frequency of collection depends on the volume of urban waste generated, the time of year, and the socio-economic status of the service area. In urban or public areas, waste from markets, hotels and restaurants is collected more frequently than in residential or rural areas.

Urban waste transportation depends on the efficiency of the collection process (Patil et al., 2021). Transport distance to processing facilities is an important issue to be considered. If treatment facilities are located far from the collection point (usually more than 16 km), a transfer station is required (Aleluia and Ferrão, 2016). Transfer stations are used as transfer points for municipal waste from collection trucks to larger transport vehicles. The transfer station arrangement helps to reduce transportation costs, by reducing the number of workers and the distance required.

After being classified, collected, transported, urban waste will be treated by different methods depending on the type of waste and the management method used in that area. Commonly used methods for municipal waste management are (1) landfilling; (2) recycling as compost, incineration; (3) burning energy recovery; (4) recycling, reuse; (5) gasification and some other methods (Ghomi et al., 2021; Hoo et al., 2020). In which, recycling as compost, recycling, reuse, incineration, and gasification are the main methods for managing urban waste according to the circular economy model.

Recycling method

Composting recycling is a method of using organic waste to make compost. Other wastes after this process will be further treated by other methods. There are two ways to treat waste by this method: aerobic and anaerobic composting (Goyal et al., 2018). To avoid having a lot of unsuitable waste mixed with the receiving waste for decomposition, a process of removing foreign substances or segregation of the waste

at source is required. The advantage of this method is that the process is simple and environmentally friendly, so when it comes to economic models, it can be used on many scales (Thai, 2014). First of all, it can be used at a small household scale to make fertilizer for crops. In addition, this method is also used in organic fertilizer factories with raw materials derived from classified organic waste, such as food waste, garden waste or agricultural waste. Moreover, recycling as organic fertilizer is also applied in the circular agricultural production process, creating environmentally friendly recirculating ecosystems.

Burning method to recover energy

While conventional incineration simply destroys waste, energy recovery incineration is a method of burning waste to recover energy in the form of electricity or heat. Urban waste treatment facilities according to this method can be understood as a thermal power plant using raw materials as waste (Wu et al., 2021). The technological process is as follows: the incinerator is equipped with a heat exchanger and a boiler to recover heat energy from the burning of urban waste (Zhang et al., 2010). The generated steam is then used to run turbines to generate electricity. Currently, there are two lines of waste incineration technology to recover energy depending on the composition of the waste. For waste sources with high calorific value (heat output), which have been sorted at the source, waste will be prioritized to use separate incineration technology for high calorific waste (Zhang et al., 2010). For waste sources with low calorific value, mixed ingredients of many types because they have not been sorted at the source, waste will use separate incineration technology for low calorific waste sources with a higher percentage of ash.

This is an economically and environmentally effective technology because it can reuse waste sources in general and urban waste in particular to recover energy, operating under a circular economy model. However, this method requires large investment, high technical requirements, and high operating costs (Patil et al., 2021). If compared with the cost of electricity production from other types of electricity generation, the cost of electricity production from waste is much higher (Rathore and Sarmah, 2020). Therefore, in order for the investment project of an urban waste incineration plant to generate electricity to be economically feasible. It is necessary to have guidelines and policies to encourage investment support, loan capital, tax, electricity selling price, etc (Tsai et al., 2020). However, this method has affected social and environmental advantages, making the most of energy from waste, reducing many sources of environmental pollution compared to incineration. This is a good choice for areas with dense population, narrow area, and abundant financial resources.

Recycling and reuse method

Recycling and reuse are considered an advanced method widely used in developed countries in managing urban

waste according to the circular economy model. One of the common rules of recycling and reuse is the 3R rule. In fact, 3R stands for "Reduce - Reuse - Recycle". For example, the recycling method is applied to e-waste (Goyal et al., 2018). This is also a way to effectively treat waste, while saving raw materials in the production of machinery and equipment. Some components and metals from e-waste can be recycled at repair and replacement facilities (Hoo et al., 2020).

Reducing daily waste is as small as possible by adjusting the production process, living habits, etc. (Goyal et al., 2018). For example, by encouraging people to use cloth bags when going to the supermarket, to store things instead. the use of plastic bags or the application of environmentally friendly methods by manufacturers instead of industrial waste that is difficult to decompose.

Reuse is an effective solution in reducing the amount of waste released into the environment (Hoo et al., 2020). The reuse of some products or some parts contained in the product for replacement and repair is of great significance.

Recycling is recycling waste into new things, serving the same or new purpose, which is also a very good solution for the human environment (Zhang et al., 2010). Maybe the products that are recycled will not have the same quality as those made from new materials, but that is a way to help save the world's increasingly depleted resources.

To apply the 3R method, waste will be treated and sorted right from the households. This is a way to reduce the amount of waste released into the outside environment, especially those that are difficult to decompose. Waste used for recycling will be centralized for cleaning at the facilities (Goyal et al., 2018). Therefore, it helps to save water as well as minimize odors such as when leaving different types of waste together.

Besides the environmental benefits, 3R also has great economic value. That is the saving of natural resources by using waste recycling (Wu et al., 2021). At the same time, the 3R method also helps to reduce the amount of waste significantly. Thereby reducing transportation costs to the place of collection, burial and treatment. In addition, the recycling method also creates opportunities for development and increases income for the scrap collection industry. The collection of recyclable waste at the source, helping establishments to buy at a low price (Goyal et al., 2018). Then, through repair, refresh for reuse.

Gasification method

Gasification is an energy recovery method based on carbide production technology through gasification of organic chemicals into combustible gases (CO, H₂, methane, CO₂) and volatile gases (steam) by pyrolysis of waste at a temperature of 400-600 degrees in the absence of oxygen (Patil et al., 2021). Thus, this method

helps to recover heat energy and the remaining solid (carbide) after gasification is rich in carbon, which can continue to be used as fuel.

The above are methods of urban waste management that can be applied in the circular economy model. However, in many parts of the world, the most common waste treatment methods are still open-air landfills, landfills and incineration. Those traditional methods are characterized by being simple and fast but causing many serious consequences for the environment and waste of resources. At the lowest level, waste is taken directly to open-air landfills, without any treatment process, so the waste is simply piled up in a certain area (Goyal et al., 2018). Not only does it take up land, when the waste decomposes, it will cause heavy pollution of water, soil, and air, greatly affecting the health and life of people. To a greater extent, municipal waste is sent to landfill. With this treatment measure, waste should be concentrated in the right place, ensuring hygiene, away from residential areas so as not to affect health and quality of life (Hoo et al., 2020). However, waste can be disposed of in sanitary landfills, either in unsanitary landfills or waste dumping sites (Goyal et al., 2018). If the landfill is not hygienic, the waste will not be collected and treated, and the waste gas and leachate will not be treated. This method occupies a large area, takes a long time to decompose, pollutes the air, water and soil in the surrounding area by dispersing emissions, odors, leachate, etc. The sanitary landfill is designed to meet the requirements of environmental sanitation, with a system to collect waste gas and leachate for treatment and to add deodorizers. Most landfills receive waste that is classified at source and has a high organic content, so its stability is low, occupies a large area of land (Wu et al., 2021). Therefore, it is easy to overload, causing environmental pollution due to odors, emissions, leachate, which in many cases causes problems that require complicated and expensive treatment, is often opposed by people. In addition, urban waste is also treated by incineration in incinerators. This way reduces the amount of waste released into the environment when the waste has been burned into ash and slag (Goyal et al., 2018). However, the incinerators need to be equipped with an exhaust gas treatment system and operate properly (Thai, 2014), otherwise it will cause air pollution due to toxic gases released during the combustion process.

4. THE CONTEXT OF APPLYING THE CIRCULAR ECONOMY MODEL TO URBAN WASTE MANAGEMENT IN SINGAPORE

Singapore has a sustainable waste management process involving citizens, the private sector and the state (Pearce and Chertow, 2017). In collaboration with these key stakeholders, the Environment Singapore Authority has developed a range of initiatives and programs to limit the proliferation of waste. At the source of waste generation, recyclables are sorted and collected for

management to conserve resources. The rest of the waste is collected and taken to factories that convert waste into energy for burning (Patil et al., 2021). Incineration reduces waste by up to 90%, saves landfill space, and the heat is recovered to create steam that drives turbine generators to generate electricity, providing up to 3% of the island's electricity needs (Wong et al., 2021). Burnt ash and other non-burnable wastes are then transported to the Tuas Marine Transshipment Station (TMTS) from where they are taken to the Semakau Landfill for final management. Singapore's National Environment Agency reports that in 2020, about 5.88 million tons of solid waste will be generated, of which 3.04 million tons will be recycled, equivalent to 19%, the remaining ash is burned to generating electricity, and for the remaining ash that cannot be further managed, it will be buried. Thus, most of Singapore's urban waste is managed according to a circular model in two methods: recycling and incineration.

Recycling and reuse method

Singapore's urban waste management system focuses on two main thrusts: waste reduction and recycling, or simply the 3Rs (Reduce, Reuse, Recycle) (Zhang et al., 2010), the 3Rs play an important role in preventing waste generation at source and bringing many benefits (Goyal et al., 2018).

Table 4.1: Rate of recycling of all kinds of waste in Singapore (2016-2020) (Unit: %)

Year Type of waste	2016	2017	2018	2019	2020
	Paper/ Carton	51	50	56	44
Black metal	99	99	99	99	99
Plastics	7	6	4	4	4
Construction and Demolition	99	99	99	100	99
Food and drink	14	16	17	18	19
Garden waste	65	67	82	73	80
Wood	78	77	71	66	64
Ash and mud	13	12	10	10	7
Testile/ Leather	7	6	6	4	4
Used slag	98	99	99	98	99
Non-ferrous metal	99	98	99	99	98
Glass cup	20	17	19	14	11
Scrap tires	91	92	90	94	95
Others (ceramic, stone, etc.)	2	2	4	7	11

Source: Singapore National Environment Agency (NEA), 2021.

In general, in the period 2016-2020, Singapore's recycling rate has always been high. In particular, for scraps such as ferrous metals, building materials, slag, and non-ferrous metals, the recycling rate is very high, close to 100%. The recycling rate decreased from 59% in 2019 to 52% in 2020. With the exception of paper/cardboard, the recycling rates of other waste streams remained the same or improved. In 2020, a decrease in the rate of paper recycling also contributes to a decrease in the overall recycling rate. Less recyclables are collected because Public Waste Collection Agency (PWCs) recycling programs have been paused during interruptions (e.g., Collection of litter, door-to-door collection, special collection teams with schools and residential centers) due to the impact of the Covid-19 pandemic. In Singapore, the waste management facilities are quite special compared to other countries. The Sarimbun Recycling Center (SRP) is located in the northwest of Singapore with an area of approximately 30 hectares and is divided into smaller plots, which are leased to companies through open tenders for waste recycling such as wood/horticultural waste, and construction waste (Biswas and Tortajada, 2021).

In particular, the amount of e-waste generated in Singapore is increasing due to technological progress leading to faster product replacement. To address the emerging challenge, the National Environment Agency of Singapore (NEA) has established a national voluntary partnership on e-waste recycling, lights and batteries with interested stakeholders. Under this voluntary partnership, industry partners will continue to take on leadership roles in spearhead recycling programs, with additional support and recognition from the NEA.

In which, the first partners are companies and organizations that create e-waste. These companies and organizations are encouraged to implement company policies to manage e-waste properly and to engage recycling service providers as members of the partnership.

The second partner is the producer (i.e., manufacturer, importer, supplier, etc.) and the retailer that puts electrical and electronic products on the market. Manufacturers and retailers are encouraged to work with other partners to promote e-waste recycling programs (for individuals/households as well as for businesses) (Biswas and Tortajada, 2021). For example, home appliance retailers might consider offering a buy-back service for unwanted devices when delivering new products and sending e-waste to registered recycling providers (Biswas and Tortajada, 2021).

A third partner is a location partner that includes schools, shopping malls, clubs and community centers, etc. Location partners are encouraged to support e-waste recycling by providing provide space for recycling bins or organize community activities to spread the message

of e-waste recycling (Carriere et al., 2020). These partners will participate in recycling programs and promote e-waste transfers to registered recycling service providers.

The fourth partner is recycling service providers: including collectors, recyclers, logistics providers, facilities managers, etc. collect, transport, sort, manage, recycle or treat e-waste. Recycling service providers are encouraged to raise their process standards (Wong et al., 2020). They must be registered and maintain a valid Recycling Provider registration status to become a member of the partnership (Zhang et al., 2010).

Besides, in order to have high recycling efficiency, with the goal of economic development, but still have to ensure a clean and beautiful environment, the Singapore government has soon applied a sustainable integrated urban waste management strategy sustainable through 3R (reduce, reuse, recycle waste). All types of waste are segregated and collected at source. The sense of segregation of urban waste (recyclable and combustible) is always well understood and strictly enforced by all residents. Every day, people sort their waste by putting paper and cardboard in a separate bag; Recycled, non-burnable waste such as bottles, jars, and batteries should be placed in a separate bag, and combustible waste such as food should be placed in separate bags (Patil et al., 2021). The classification of waste will help the cleaning staff of the apartment complex to quickly collect it before sending it to a truck to be transported to the garbage disposal site. In public places, on the streets of Singapore, there are garbage bins with 4 compartments, specifically divided according to each type of waste, including cans, paper, plastic and other garbage (Patil et al., 2021).

Along with the scientific method of garbage classification, Singapore also formed and developed a very effective garbage collection mechanism (Biswas and Tortajada, 2021). Accordingly, the garbage collection is organized public bidding for businesses in each area. In fact, Singapore has 9 garbage collection areas. The winning company will collect garbage in a specific area within 7 years and the Singapore Government will manage this activity in accordance with the law (Biswas and Tortajada, 2021). In order to improve the quality of garbage collection services, since 1999, the Singapore Government has allowed privatization of activities in this field. Specifically, private companies providing garbage collection services will be licensed to operate if they win the bid and are subject to the supervision of the Singapore Ministry of Environment and Water Resources. Such companies must comply with regulations on waste classification, use garbage collection facilities and equipment so as not to affect the environment and the health of the community (Patil et al., 2021). The garbage collection company will provide collection services, urban waste will be transported to the large garbage collection area (Transshipment station) according to regulations; Recycled waste is collected and treated according to the

National Recycling Program. Among the garbage collection contractors in Singapore, there are currently 4 public sector contractors responsible for garbage collection at state agencies, the rest are private enterprises (more than 300 companies), mainly carry out waste collection at industrial, construction and commercial facilities (Biswas and Tortajada, 2021). At present, about 50% of Singapore's waste is collected by private enterprises (Patil et al., 2021).

In order for people to understand the process of garbage classification and collection, according to NEA Singapore (2021), information and instructions on garbage collection are still regularly sent to them through mass organizations and urban councils under the leadership of MPs who are members of the ruling Party, or the opposition Party elected through the National Assembly elections. In particular, at shops, supermarkets, recycling centers, garbage collection places of residential areas, people can exchange garbage such as paper, cardboard, plastic, old mobile phones have been carefully sorted and exchanged for cash, discount vouchers, exercise cards, tickets to visit a certain tourist attraction in Singapore.

In addition, in order to inculcate the habit of recycling from an early age, the Singapore National Environment Agency and F&N company launched the RVM School Education Program under the Recycle & Save initiative in March 2020, including in primary school and secondary school. Participating schools organize their own activities to encourage students to practice 3Rs (Reduce, Reuse, Recycle) such as holding recycling competitions between grades and grades within the school. As such, schools can use the National Environment Agency Singapore's School Environment Fund to support these activities. Although there are very strict sanctions for littering in the wrong places, the Singapore Government does not consider this a priority measure. They have strengthened the organization of propaganda, dissemination, awareness raising, and mobilization of people's participation, which is an effective and fundamental measure to reduce waste generation and increase the garbage collection rate. In addition, the Singapore Government also mobilized schools, offices, shopping malls and industries to participate in the National Recycling Programme. This is to help educate and form the awareness and habit of garbage collection among students, officials and employees (Biswas and Tortajada, 2021).

Burning method to recover energy

In the past, Singapore has also been stuck with the problem of garbage, even in 1960, the government of this country had to declare that the country was running out of space to dump garbage. However, in 1979, this Singapore found an effective solution and maintained it to this day, turning Singapore into one of the countries famous for its clean and beautiful environment - burning garbage to generate electricity (Tan and Cha, 2021). In 1979, Singapore built the first incineration plant, not

only to treat waste but also to turn waste into energy. It is this right solution that tackles the vast majority of waste in the country with the ability to process up to 90% of the country's waste and turn it into electrical energy. Incineration plants are also known as waste-to-energy plants (Biswas and Tortajada, 2021). The incineration plant is a closed process. Starting from receiving waste in a basement to prevent odors, it is then ground and burned to produce steam that turns turbines to generate electricity. Moreover, the smoke emitted from this process is also treated with all harmful substances before being discharged, ensuring no pollution to the environment (Tan and Cha, 2021).

Currently, according to NEA Singapore (2021), Singapore has four waste-to-energy plants: Tuas, Senoko, Tuas South and Keppel Seghers Tuas Waste-To-Energy Plant (KSTP). In particular, KSTP was put into operation in 2009 to replace Singapore's first incinerator for power generation at Ulu Pandan, which closed in August 2009 after 30 years of successful operation. The Senoko Incineration Plant was also divested to the private sector in September 2009 and has since been renamed the Senoko Waste-to-Energy Plant (SWTE). However, not 100% of the waste is completely treated by the incinerator, but there is still a large amount of waste and ashes that cannot be treated, which will be transported to the Semakau Landfill via the transfer station. Tuas. The Tuas Marine Transfer Station (TMTS) is an intermediate collection point for ash from waste-to-energy plants and non-incinerated waste before it is transported to the Semakau Landfill. Built at the same time as the Semakau Landfill, it is located next to the Tuas South Incineration Plant. All collection vehicles licensed to carry non-inflammable waste will be pre-weighed at the weighbridges prior to transfer. In particular, to conduct garbage collection, Singapore built the Semakau garbage island by relocating the people on the two islands of Pulau Semakau and Pulau Sakeng to the mainland (Tan and Cha, 2021). Then, they built the embankment from the gap between these two islands, inside the embankment was divided into small cells to store garbage. After dumping the garbage, they also fill it with soil to attract birds and insects to live. Without the smell of garbage, and with many birds, this garbage island not only does not affect the surrounding environment but also becomes an attractive tourist destination (Pearce and Chertow, 2017).

5. LESSONS FOR VIETNAM IN MANAGING URBAN WASTE IN LINE WITH THE CIRCULAR ECONOMY MODEL

5.1 The context of applying the circular economy model to urban waste treatment in Vietnam

The collection, transportation and treatment of urban waste in Vietnam is posing many challenges to the whole society. In recent years, environmental pollution from urban waste, especially in landfills, has been a pressing issue for society. In addition, a part of waste

from abroad with diverse compositions imported into Vietnam in the form of imported scrap has not yet met the national technical regulations on the environment, creating a burden for the domestic waste management (Bui et al., 2020). Non-biodegradable plastic waste is also a challenging problem in today's urban waste management. In addition to the impacts on the natural environment such as landscape, greenhouse gases, soil and groundwater pollution, air pollution, etc., the control and treatment of urban waste is not effective but also causes many impacts on public health as well as potential conflicts in the areas around the waste treatment facility (Hoang and Fogarassy, 2020). It can be said that in Vietnam, urban waste is usually treated by main methods including landfilling; recycled as organic fertilizer; burn and destroy; burning to generate electricity; gasification; recycling, reuse and other methods. In which, the methods of recycling as organic

fertilizer, burning for power generation, gasification, recycling and reuse are methods of urban waste treatment applied according to the circular economy model (Nguyen et al., 2020).

Recycling method to make organic fertilizer

Recycling as compost is a simple and effective method of organic waste treatment. According to the State of the Environment Report 2019 (Ministry of Natural Resources and Environment), there are 37 establishments using this technology to produce organic fertilizers, mainly for forestry and industrial plants. In mid-2020, Biwase's waste-to-organic fertilizer treatment plant with a capacity of 840 tons per day in Binh Duong was put into operation with the largest scale in Vietnam and Southeast Asia at that time

Table 5.1: Rates of food and garden waste in some localities in Vietnam

Location	Hai Duong (2011)	Lam Dong (2012)	Dak Nong (2012)	Ho Chi Minh city (2017)	Hoi An (2017)	Hai Phong (2018)	Hanoi (2018)
Ratio (% wet weight)	71,13	71,8	65,5	59,2	57	46 - 49,8	51,9

Food and garden waste are biodegradable organic substances that can be used as compost. In the localities considered in the above table, the rate of this type of waste is quite high, the lowest is nearly 50% of wet weight in Hai Phong (2018). In Lam Dong (2012), Hai Duong (2011), this percentage is up to more than 70% of wet weight. Thus, this is a huge source of available raw materials for making organic fertilizers. In Vietnam, agriculture plays an important role in the economy, so making organic fertilizer is a very effective treatment method, bringing great benefits to agricultural production. While fertilizers need to be used regularly in agricultural cultivation, but now the excessive use of fertilizers and chemical pesticides has caused the environment to be severely affected. The soil is degraded, affect crop yield and quality. According to a report on circular economy development in agriculture and rural areas in Vietnam of the Institute of Strategy and Policy on Natural Resources and Environment (Ministry of Natural Resources and Environment), in recent years, Vietnam is a trade deficit country. about fertilizers and pesticides, with the spending of billions of USD. Therefore, the model of using waste to make organic fertilizer has helped to utilize organic waste into useful products for use. Moreover, recycled organic fertilizer also helps people reduce production costs, thereby increasing their income, while contributing to environmental protection (Tong et al., 2021; Tsai et al., 2020).

Vietnamese enterprises have also had many projects

Source: Ministry of Natural Resources and Environment, 2019 towards the circular agriculture model. Vinamilk - Vietnam's leading dairy company is aiming to balance production and business growth with environmental and social responsibility (Hai et al., 2020). One of the important principles in the circular economy chain is to aim for nothing to be discarded. At Vinamilk's farms, livestock waste through modern collection and treatment technology and Biogas system is separated into solid fertilizer or processed into liquid fertilizer to fertilize pastures and soil improvement. In fact, in addition to the facilities and factories that produce organic fertilizer from waste, Vietnam also has many localities that have well implemented the model of composting waste to make organic fertilizer at household scale (Hai et al., 2020). In Hai Phu commune, Hai Hau district, Nam Dinh province, thanks to the well-implemented model of waste separation at source, people have been able to effectively use recycled organic fertilizers from waste to increase nutrients for soil, and significantly reduce the cost of buying chemical fertilizers. In Thanh Hoa, the Women's Union of Rung Thong town, Dong Son district has had a model of "Composting pits into organic fertilizer" to reduce the amount of waste, have fertilizer for plants and contribute to cleaning up the environment. In Hoi An city, Da Nang, a community volunteer group held sessions to teach people how to recycle and reuse organic waste, especially fermenting organic waste to create fertilizer. In general, the waste recycling model for making organic fertilizer has been interested and applied in Vietnam but is still being gradually

popularized. It is necessary to continue to replicate these models properly with Vietnam's large organic waste resources.

Burning method to recover energy

Incineration and energy recovery is a method of waste treatment with high economic and environmental efficiency, turning waste into resources. On the other hand, because this method requires high-tech lines, large initial investment capital, takes a long time to recover capital and complicated legal procedures. Thus, it can be seen that although the potential is quite large, it cannot be widely applied. Currently, Vietnam has only a few facilities applying this technology, typically the waste power plant in Can Tho, which was put into operation at the end of 2018. According to the Department of Natural Resources and Environment of Can Tho, since put into operation (December 2018) by the end of October 2019, Can Tho garbage power plant has treated about 175,000 tons of urban waste of the city, generating 53.2 million kWh of electricity. Currently, this plant has treated about 70% of Can Tho's daily waste, equivalent to 400-430 tons of waste per day and generated more than 170000 kWh of electricity per day. Besides, in recent years, a series of garbage power plants have been built in many localities such as Vinh Tan garbage power plant (Dong Nai), Tram Than garbage power plant in Phu Tho, power plants Cu Chi garbage in Ho Chi Minh City, Soc Son garbage power plant in Hanoi, etc. In which, the Soc Son waste incineration project is the largest waste treatment plant in Vietnam up to the present time, with the total investment cost 7,000 billion VND, and just put into operation at the end of May 2021. It is expected to be able to process more than 2/3 of Hanoi's waste. In addition, in Ho Chi Minh City, there are currently two projects to build a waste incineration plant for electricity generation, which have started vigorously, the project of Vietstar company and Tam Sinh Nghia company, which have been started but still is being stopped pending licensing (Hoang and Fogarassy, 2020; Schneider et al., 2017).

Recycling and reuse method

Recycling and reuse are a method of thoroughly dealing with waste, applying a circular economy model, especially useful for some types of waste such as paper, newspapers, plastic, metal, old clothes, appliances, electronics, etc. (Goyal et al., 2018). However, Vietnam does not have a strong enough industry to support recycling (Schneider et al., 2017). Currently, there are more than 200 waste recycling enterprises (Hai et al., 2021), but most of them are small and medium enterprises and private companies as well as technology is still limited. It leads to low economic efficiency.

In fact, in addition to recycling businesses, social activities on recycling and reuse have also been interested in developing. Recently, Nestle Vietnam has cooperated with the Central Committee of Ho Chi Minh Communist Youth Union to build a playground for

children with recycled environmental protection materials such as milk cartons and tires. These projects not only provide children with a dynamic and creative playground, but also encourage physical training, especially spreading the awareness of environmental protection.

With the unique idea of building a bridge with beer bottle caps, Tiger beer brand has researched and found ways to recycle this material because bottle caps are often not on the scrap collection list, the recycling value is small. When this brand proposed the project, thousands of tons of beer bottle caps were donated by people, collected at retail points and transferred to the recycling company. Here, the bottle caps are melted, treated at low temperatures to help prevent harmful emissions into the environment, and then mixed with other materials to create iron materials for use in the process. build a bridge. Under the cooperation of people and businesses, two bridges Kenh Nang and Hoa Binh (An Giang) built with recycled materials have been put into use to help people travel more smoothly. Hence, from bottle caps with very small recycling value, the project has brought new constructions and improved essential infrastructure for the community.

Another example of a creative recycling idea is building a house from recycled plastic and rice husks in Long An - Mr. Phan Trong Hoan's invention has been patented by the National Office of Intellectual Property for useful solutions. To implement this idea, it took Mr. Hoan 22 years of research to find a method to combine rice husks and plastic waste, thereby successfully giving birth to the first house in 2013. After the first house which made from rice husks and plastic waste successfully designed by Mr. Hoan, more houses made from plastic waste followed and appeared in many provinces and cities across the country. In particular, there is a house located right in the earthquake area but still standing and remain stable.

Gasification method

Gasification is a method of converting waste into synthetic gas for electricity generation without separating organic or inorganic waste, obtaining black soil as a raw material for organic agriculture without releasing water or smoke, toxic gases into the environment (Goyal et al., 2018; Hoang and Fogarassy, 2020). Currently, this technology has been applied at the waste power plant in Hung Yen and Dong Van industrial zone (Ha Nam). The high-tech waste treatment plant in Hung Yen is the first to apply this technology. This is also a garbage power plant; however, it does not burn waste to generate electricity, but will process waste in high temperature and lack of oxygen to produce gas as fuel to run generators with its own suitable process with the characteristics of waste with high humidity in Vietnam. Not only treating waste, but the company also provides people around the factory area to try organic materials to improve the soil every month (Hoang and Fogarassy, 2020) - one of the products of the waste treatment process and has received many positive

feedbacks.

The above are methods of urban waste treatment applied according to the circular economy model in Vietnam. However, these methods only treat a small part of the actual amount of urban waste. Currently, Vietnam still mainly treats urban waste by two methods: burial and incineration (Nguyen et al., 2020). Landfilling is one of the traditional methods, which is very popular in Vietnam (Thai, 2014; Schneider, 2017). According to the Ministry of Natural Resources and Environment, in 2019, about 71% of collected waste will be treated by landfilling at more than 900 landfills. However, only about 20% of them are sanitary landfills. Landfills that are unhygienic, have not been treated to ensure environmental hygiene and do not take advantage of the amount of waste still make up the majority, because in many places people still have the habit of throwing garbage indiscriminately, garbage is not collected and treated leading to derelict spontaneous landfills. To improve this situation, in 2018, the government had a Target Program to thoroughly treat establishments causing environmental pollution in the period 2016-2020, but so far, these landfills have not been treated due to lack of resources.

Sanitary landfilling is the main method used in large urban areas such as Hanoi, Ho Chi Minh City, and Da Nang (Schneider et al., 2017). In Ho Chi Minh City, 69% of municipal waste is treated by sanitary landfill. Besides, sanitary landfills also have many problems such as overcrowding, causing environmental pollution and affecting surrounding people (Schneider et al., 2017). For example, Nam Son landfill, the largest in Hanoi, has been overloaded after more than 20 years of operation. One day Hanoi generates up to 6,500 tons of urban waste, 5,000 tons are sent to Nam Son landfill for burial in 2019. Due to many years of operation without much expansion and improvement, Nam Son landfill gradually fell into overcrowding. Moreover, at the peak in 2010, this landfill had a situation where people blocked garbage trucks due to frustration about pollution, the delay in compensation for site clearance for people living around 500m from the landfill. As a result, the amount of stagnation of garbage is increasing, garbage is piled up, garbage trucks are long on the streets, giving off an unpleasant smell that affects people around and people in traffic. Although Hanoi solved this problem, the problem of waste treatment of the whole big city has not been completely solved because landfilling cannot be a long-term and effective solution for the current waste situation. In addition, Vietnam also has a number of places that have successfully treated closed landfills such as turning the landfill into a clean ground to build an urban area in Me Tri (Hanoi), treating pollution for Soi Nam landfill (Hai Duong), building a park from a landfill in Quang Ninh, etc (Tong et al., 2021). Thus, with the increasing amount of urban waste, it has been overloading the land fund used for landfill in Vietnam. The landfill method is no longer suitable, there should be other alternative methods to protect the environment, take advantage of

energy recovery from urban waste sources to bring waste back as raw materials for the circular economy (Tsai et al., 2020).

Incineration is a fairly common waste treatment method in Vietnam (Thai, 2014; Nguyen et al., 2020). According to the State of the Environment Report 2019 of the Ministry of Natural Resources and Environment, Vietnam has 381 incinerators, of which 294 have a capacity of over 300 kg/h and can fully meet the requirements of the Technical Regulations. incinerator country. In addition, there are still many small-sized incinerators that do not have exhaust gas treatment systems that meet environmental protection standards. In many localities, when applying this method, it often encounters a number of problems such as: low heat capacity, high humidity, operators do not have appropriate technical qualifications, so they cannot monitor the emissions generated. According to the report of the Urban Committee (Hanoi City People's Council) in 2019, Hanoi is the locality with the burning and destruction rate accounting for 11%. Currently, a number of waste incineration plants in Hanoi such as Son Tay waste treatment plant, Xuan Son waste treatment plant, and Thanh Quang Investment Joint Stock Company's waste treatment plant over time have been operating. The operating system has been degraded, the capacity is not guaranteed, and the operation is often stopped for maintenance and repair, clearly showing the unreasonableness when choosing technology. Although the method of incineration can treat waste, reducing 80-90% of the volume of waste, solving the problem of land fund compared to the burial method, but it has not yet taken advantage of the waste source. Therefore, this method is still only a short-term temporary solution, requiring more investment and treatment to recover energy.

Finally, waste treatment is an urgent issue of every country including Vietnam. In order to choose a suitable waste treatment technology, in addition to the economic, social and budgetary conditions, it is advisable to aim at those technologies that must meet the requirements of environmental protection, ensure sustainable development. However, in reality, Vietnam's urban waste treatment methods still focus on destroying garbage, using garbage as its name "garbage", not only wasting resources but also environmental pollution (Nguyen et al., 2020). A number of recycling methods such as composting, incineration, energy recovery, recycling and reuse have been gradually applied instead, but there are still many limitations (Tsai et al., 2020). The treatment of urban waste in Vietnam poses many challenges for the government, businesses and people (Bui et al., 2020). These are important and urgent issues that need to be addressed in the direction of recycling urban waste according to reasonable methods for sustainable development of the country and environmental protection.

5.2 Orientation for urban waste treatment activities in line with the circular economy model in Vietnam

In Vietnam, the development orientation of urban waste treatment according to the circular economy model has been gradually mentioned by the Party and State in guidelines and policies since 1998 with Directive 36/CT-TW introduced "applying clean technology, low waste, low consumption of clean raw materials and energy". Then, in Resolution 41 (2004) mentioned "encourage recycling and use of recycled products", "recall and dispose of used products". By 2012, Vietnam's sustainable development strategies for the period 2011-2020, respectively; environmental protection strategy to 2020, vision to 2030; approved Green Growth strategy, gradually bringing the circular economy model closer to Vietnam. Since then, Vietnam has had policies related to "exploiting and saving natural resources", "using renewable energy", 3R-saving, reusing, recycling, "replacing" "plastic bags", "sustainable production and consumption", "green supply chain", "green consumption", etc.

In particular, in 2018, the Government made adjustments to the National Strategy on Integrated Solid Waste Management with specific goals for each period up to 2015, 2020, 2025. Specifically, the target until 2020. By 2025, 100% of urban areas that recycle solid waste will be classified at households; 100% of the total amount of municipal solid waste generated will be collected and managed to ensure the environment, of which 90% will be recycled, reused, recovered energy or produced organic fertilizer; 90% of total construction solid waste generated in urban areas is collected and treated, of which 60% is recovered for reuse; etc.

Promulgated in 2020 and effective in 2022, the country's Law on Environmental Protection 2020 has many provisions on circular economy development. The concept of a circular economy is also clearly defined in this law. In addition, the Law on Environmental Protection 2020 also provides regulations to expand the responsibility of manufacturers and importers (EPR). In Vietnam, EPR was regulated for the first time in the Law on Environmental Protection 2005 with regulations on recalling and handling discarded products and was concretized in Decision No. 50/2013/QĐ-TTg dated 9/8/2013 of the Prime Minister. After that, EPR was continued to inherit and regulated in the Law on Environmental Protection 2014 with regulations on responsibility for recalling and handling discarded products and was specified in Decision 16/2015/QĐ-TTg in May 2015 of the Prime Minister. However, due to various reasons, EPR has not been implemented in practice in Vietnam.

Specifically, in the Law on Environmental Protection 2020, manufacturing and importing enterprises and individuals must be responsible for collecting, recycling or making financial contributions to the process of waste management for products at the end of the cycle. life. Regarding recycling responsibility, manufacturers and importers are responsible for recycling products and

packages they produce and import according to a mandatory recycling rate and mandatory recycling standards. Products and packages that must be recycled are products and packages with recycling value, including batteries and accumulators; electrical and electronic equipment; tires; lubricating oil; packaging (Bui et al., 2020). To fulfill their responsibilities, manufacturers and importers can choose one of four forms: (1) Self-recycling; (2) Hire units with recycling function; (3) Working together to establish a representative organization to perform the manufacturer's responsibilities to organize recycling activities; (4) Contributing funds to the Vietnam Environmental Protection Fund to organize recycling. Regarding management responsibilities, individuals manufacturing or importing products and packages containing hazardous substances, making it difficult to collect, handle or not be able to recycle (e.g. packaging containing plant protection drugs and pesticides; diapers, sanitary napkins, disposable wet wipes; gum; cigarette; products, packaging manufactured and imported using plastic as an ingredient) must make financial contributions to the Vietnam Environmental Protection Fund to directly support activities of collection, management, research, and initiatives for domestic waste management. This tool is considered an important key to promote the circular economy and solve the problem of the waste crisis, as evidenced by its successful application in many countries around the world (Aleluia and Ferrão, 2016). Currently, the Ministry of Natural Resources and Environment is also developing criteria, roadmaps and mechanisms and policies to promote the circular economy in Vietnam.

Thus, with a large source of urban waste in Vietnam, the circular economy development orientation will focus on making the most of it, turning waste into a resource, and focusing on preventing and minimizing urban waste (Hoang, and Fogarassy, 2020). This promotes waste separation at source, promotes collection and transportation, increases reuse, recycling and especially urban waste management by applying advanced management technologies, limiting landfilling, safe and suitable to local conditions. In addition, the integrated management of solid waste in general, and urban waste in particular, is a common responsibility of the whole society (Schneider et al., 2017). In addition, the State plays the leading role as one of the priorities of environmental protection, contributing to sustainable control of the country.

5.3 Lessons for Vietnam in managing urban waste in line with the circular economy model

Learn from experiences in managing urban waste according to Singapore's circular economy model. Besides, Vietnam and Singapore are both Southeast Asian countries and members the ASEAN community, having the same natural environment and climate, Vietnam should learn from the experience of this neighboring country.

Develop clear and transparent mechanisms and

policies for urban waste management

In Singapore, the penalties for indiscriminate littering are applied very harshly, litterers not only lose fines but also to wear the signature green uniform to clean designated public places. The country also recently implemented an expanded manufacturer's responsibility (EPR) system, starting from e-waste in 2021 (Patil et al., 2021). Another important factor contributing to higher recycling rates is thanks to the increased recycling rate. The collection system is highly effective when the government of this country has clearly stated in the Law that stipulates the responsibilities of producers: anyone who produces, transfers, or imports a certain product must ensure that after when using this product can be collected, transported, recycled or disposed of without polluting the environment. From the useful experiences of Singapore and based on the reality in Vietnam, Vietnam needs to have solutions on mechanisms, current policies to improve the efficiency of urban waste management according to the circular economy model. In addition, the Vietnamese government should also have strong sanctions and punishment frameworks for urban littering for citizens and organizations. Especially, the classification and disposal of urban waste according to the cycle of large production enterprises need to be strictly inspected and controlled.

Firstly, develop preferential policies, support, encouragement or tough measures to better collect, transport and classify, thereby serving as a premise for subsequent waste treatment activities. At the same time, flexibly apply policies to different localities, suitable to the development conditions of each region. Secondly, develop policies to encourage the private sector to participate in waste treatment projects and apply the collection of household waste fees. The companionship of the private sector in construction, management and operation will bring efficiency, ensure the stability and sustainability of the project when all are closely related to the interests of businesses as well as the interests of people. Thirdly, perfect and strongly apply policies that require manufacturing enterprises to use environmentally friendly materials that are easy to recycle and reuse. trading and manufacturing enterprises are also responsible for the recovery and recycling of discarded products. Finally, develop a process to guide the selection of investors and urban waste treatment projects with advanced technology, environmental protection and high economic efficiency. This solution will help to have more access to modern technology, eliminating the situation of putting in projects with outdated technology, after being built and put into operation, it has become old technology ineffective, but costly and time consuming. To be effective, the government needs to take measures to regularly check and study all the policies it has put in place to make timely adjustments to ensure effective implementation.

Increase financial resources for urban waste treatment activities

Financial resources are the most important factor to

implement urban waste treatment projects in a modern, environmentally friendly direction because most of the higher technologies, the greater the financial requirements (Rathore and Sarmah, 2020).

In Singapore, the treatment of municipal waste is market-based, so besides the state, other private actors also have the right to participate in waste management goods and services (Zhang et al., 2010). For example, the market for e-waste collection and recycling services was born with buyers being households and sellers being service providers (Wong et al., 2021). This market not only creates jobs for workers, protects the environment but also creates profits for businesses while the state does not need to spend money to treat e-waste pollution but still can put e-waste into the treatment cycle (Patil et al., 2021).

In Vietnam, because financial resources for urban waste treatment are still heavily dependent on the limited budget of the state (Thai, 2014), it is necessary to have solutions to increase financial resources:

Firstly, like the application in Singapore, Vietnam needs to focus on perfecting regulations on service charges for urban waste collection, transportation and treatment, and develop regulations on collection of fees for waste generation (Hoang and Fogarassy, 2020). The collection of fees according to the amount of waste generated will help emitters be more conscious in reducing waste and increasing recycling. In addition, this fee can be reduced for those who have already sorted their waste to increase the efficiency of waste separation at source. Secondly, research and implement preferential policies towards socialization for urban waste treatment projects. To do this, it is necessary to first assess and synthesize the capital needs; flexibly deploying investment capital mobilization mechanisms with special incentives. The good coordination between the state, businesses and the community will strengthen and diversify investment resources for urban waste treatment, reducing the burden on state spending.

As a result, urban waste management needs to be carried out in the direction of socialization, turning the waste treatment that depends largely on state management into a vibrant market, combine financial resources flexibly to achieve the highest efficiency in waste treatment and circular economy development.

Raise public awareness about sorting waste at source and reducing-recycling-reusing

Urban waste is a human product. Therefore, to be able to handle this issue well, one of the first important key points is people's consciousness. In developed countries, when people's living standards are high, they will have a better sense of environmental issues (Aleluia and Ferrão, 2016). It can be seen that in Singapore, people are very conscious of reducing waste and keeping the country green and cleaner (Patil et al., 2021). The work of sorting waste in Vietnam may be strange, but in this country, it is just a simple job when they themselves have formed the habits of garbage sorting from the

beginning. In addition, in other countries, raising public awareness of environmental issues and protection is often coordinated between businesses and the state. Hence, the sorted waste will be easier and more efficient.

In Vietnam, in order to raise public awareness on the issue of urban waste, it is necessary to organize propaganda for people to be more aware of waste reduction, recycling and reuse activities. When implementing waste separation activities in Vietnam, one of the difficulties often encountered is due to uneven implementation and inadequate facilities (Nguyen et al., 2020). In some places, responding to the implementation of waste at source but only for a while, then abandoned because people sort it, but when it comes to garbage collection, it is lumped together. In addition, because the density of garbage collection in some places is not regular, the sorted waste will be picked up by bottle pickers and then put in the bins. In addition, the trash bins with separate colors and labels to collect each different type of garbage, but only for a while, were damaged and lost (Hoang and Fogarassy, 2020). Garbage collection trucks in many places have not been invested to collect each type separately. Therefore, the classification of garbage is turned into a vicious cycle due to poor coordination among stakeholders.

Consequently, training and propaganda programs on waste segregation at source, enhancing reduction-recycling-reuse can be carried out directly at schools, agencies, public places, or on the radio, television programs, social networks with conditions suitable to the audience and circumstances are very necessary activities. In addition, it is necessary to promote propaganda and training for all businesses to move towards environmentally friendly production activities.

Promote the recycling and reuse market

Recycling and reuse play a huge role in the circular economy. This is the most effective method when dealing with municipal waste, but it is not as costly as other methods.

In Singapore, since 2001, the government has implemented a waste treatment program to increase recycling rates through segregation of waste at source from households, markets, and businesses, the recycling rate in 2019 has reached 60% (Wong et al., 2021).

In Vietnam, the recycling and reuse market, although it has been operating for a long time, has not been as effective as its inherent capacity (Thai, 2014). Therefore, measures to promote this market development are very necessary.

Firstly, it is necessary to focus on improving the efficiency and efficiency of waste separation from the source as a basis for reuse and recycling facilities, avoiding waste of material and energy resources from urban waste. Secondly, research, development,

technology transfer in the direction of modernity, environmental protection in the direction of waste treatment according to a circular model such as reuse, recycling as organic fertilizer, energy recovery, etc. Thirdly, develop and implement a program to reduce non-biodegradable plastic waste from production to consumption, then classify, collect, transport and treat appropriately.

Acquire and develop high and advanced technologies for urban waste management

In the 4.0 technology era, technology is an indispensable factor for the development of any industry and urban waste treatment is also an extremely important factor currently (Tong et al., 2021). In the world, the countries that handle urban waste well all possess advanced treatment technologies. Singapore has such advanced waste treatment technology that it has to import waste from other countries to get enough raw materials for the plant to operate (Patil et al., 2021). This country also has a series of waste incineration plants to recover electricity, processing 90% of the country's waste (Wong et al., 2021).

Vietnam is a country with limited technology, techniques as well as infrastructure in waste treatment, so choosing the right technology is very important. From the experiences of Singapore, Vietnam should prioritize investment in centralized waste treatment plants with modern and advanced technology, especially waste power plants. In addition, it is necessary to promote research and technology transfer activities, encourage enterprises to participate in pilot production projects, and receive technology transfer for urban waste treatment. When receiving new technologies from abroad, it is necessary to research and test, evaluate their effectiveness fully and objectively, to avoid success in research. However, when put into practice, it cannot be used because the characteristics of urban waste in Vietnam are much different from that of foreign countries. At the same time, research and develop more to apply in accordance with the conditions of Vietnam. In addition, it is necessary to train human resources with high technical and professional qualifications to acquire technology to be able to use high technology and operate urban waste treatment projects with the highest efficiency (Nguyen et al., 2020).

6. CONCLUSION

In the current situation of world economic development, circular economy has become a trend that every country is aiming for. This model can be applied to all consumption and production activities, effectively solving problems of environmental resources and pollution, and contributing to improving economic efficiency. Applying a circular economy model to urban waste treatment helps to reduce costs for input materials

when it is possible to make the most of waste sources, reducing the amount of waste released into the environment. Thereby, avoiding resource depletion, minimizing environmental pollution and sustainable economic development, improving the quality of life for people. Singapore is an island nation that recycles and burns to generate electricity almost all of their municipal waste with a green - clean - beautiful and environmentally friendly ecosystem. This paper clearly shows that Vietnam needs to develop clear and transparent mechanisms and policies in the treatment of urban waste because the State always plays an important role in orienting the development of urban waste management in line with the circular economy model. Besides, Vietnam also needs to strengthen financial resources to provide enough capital, infrastructure and absorb the development of new technologies. In addition, raising public awareness about urban waste treatment is also extremely necessary to be able to closely and effectively coordinate between people, businesses and the state in reduce - recycle - reuse. In particular, Vietnam needs to strongly promote the development of the recycling and reuse market because this is the simplest and most effective method when bringing waste back into the circulation. In summary, with Singapore's experience with the development of a circular economy model, Vietnam has advantages in absorbing and learning to apply international experience to the development of the circular economy model in general and the urban waste management in line with the circular economy model in particular. Promoting the effective development of urban waste treatment according to the circular economy model should continue to be of interest and pay more attention in the coming time to ensure a sustainable development of the economy and contribute to environmental protection and improvement of people's living standards.

7. REFERENCES

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