International Journal of Academic Management Science Research (IJAMSR)
ISSN: 2643-900X
Vol. 8 Issue 10 October - 2024, Pages: 51-60

Circular Economy and Waste Management in Production and Consumption: International Experiences and Some Policy Recommendations for Vietnam

Dr. Le Thi Thanh Binh

Institute for Regional Sustainable Development Studies -

Vietnam Academy of Social Sciences

Abstract**:** *The circular economy and waste management have become indispensable approaches for achieving green transformation and sustainable development. This paper reviews international experiences in waste management aligned with circular economy principles in production and consumption, extracts lessons learned, and identifies challenges faced by Vietnam in implementing circular waste management. Based on these findings, the paper proposes policy implications for Vietnam in waste management toward a circular economy in production and consumption. A new contribution of this paper is that it distills global lessons for a developing country like Vietnam and offers some main policy recommendations for Vietnamese government agencies, businesses, and consumers.*

Keywords: *Circular economy, waste management, Vietnam*

Introduction

Circular economy is a strong and inevitable trend in the world to implement sustainable development goals successfully. In a circular economy, natural resources are used optimally by closing the production cycle, raw materials are designed to be economical and ensure regeneration right from the input stage, and material flows are managed and recovered most effectively before being released into the environment. Thus, circular economy helps economies redefine production and business models in a more optimal and efficient direction, extending product life cycles and protecting the environment by maximizing the use and conversion of waste into inputs for many other production processes.

The development of the "brown economy", following the linear economic model has exhausted and wasted resources, causing serious environmental damage. Therefore, to overcome the shortcomings of the linear economic model, it is necessary to apply a circular economic model with a looping nature in the use of material and resource flows (Korhonen et al., 2018). Kirchherr, Reike and Hekkert (2017) reviewed 114 definitions of the circular economy, analyzed the connotation on 17 different dimensions, and showed that the circular economy is mainly understood as a combination of reduction, reuse, and recycling activities, thereby increasing economic prosperity, protecting the environment, and effectively managing resources.

Waste and pollution have been an urgent issue globally for decades, with red flags from industrial waste, and household waste, especially plastic waste. In addition, climate change is also becoming more and more serious, with extreme weather events and the urgent need to reduce greenhouse gas emissions. To solve the problem of waste, combat environmental pollution and respond to climate change, countries around the world within the framework of the United Nations have committed to implementing 17 sustainable development goals for the period 2015 - 2030. The United Nations High-Level Conference on Solving Plastic Pollution (UNESCO) on May 27, 2023, also set goals to strengthen waste management, especially plastic waste, to avoid a global waste disaster in the future. Currently, Vietnam is at the top of the world in terms of environmental pollution and plastic waste. The management of domestic waste sources in Vietnam still faces many difficulties, especially plastic waste. According to the Department of Environmental Pollution Control - Ministry of Natural Resources and Environment of Vietnam, by 2023, about 60,000 tons of waste will be generated every day, of which urban waste accounts for about 60% and rural waste accounts for about 40%. It is forecasted that by 2025, the rate of domestic solid waste generation in Vietnam will increase by 10 to 16% per year[1]. To address the general situation of waste, protect the environment, and keep up with the current trend of circular economic development in the world, Vietnam has also committed to reducing net emissions to "0" by 2050 at the COP26 Conference in November 2021. In 2020, Vietnam passed the Law on Environmental Protection, officially legalizing regulations on the circular economy.

However, Vietnam still does not have a comprehensive national strategy or action plan for the circular economy model and circular economy waste management. Domestic solid waste management activities are still facing many difficulties and obstacles, mainly in terms of mechanisms, policies, management models, and coordination mechanisms between ministries, sectors, and localities. Other limitations include capital sources, investment and implementation costs, technology selection, monitoring activities, reporting, database development and updating, communication, and community education. The above situation shows that it is necessary to study the experiences of waste management and circular economy implementation of countries around the world so that we can learn and apply them in Vietnam, helping Vietnam catch up with the world. This article aims to summarize the

[1] https://pcd.monre.gov.vn/quan-ly-chat-thai/5745/ap-luc-ve-van-de-xu-ly-rac-thai-sinh-hoat-o-nuoc-ta-hien-nay.

experiences of some countries in the world on waste management toward the circular economy and draw some lessons and policy implications for a developing country like Vietnam.

1. Circular economy and the principle of closed-loop operation

* *The concept of circular economy*

The 1960s marked the emergence of the environmental protection movement, but the term "circular economy" was not yet clearly defined. From 1960 to 1985, the focus was on waste management, particularly the polluting effects of waste. Consequently, resource life extension strategies (RLES) were emphasized during this period, mainly related to the end-of-life (EoL) processes of both industrial and municipal waste, along with preventive measures focused on the production side of industrial systems. Waste management strategies such as cleaner combustion, waste-to-energy, recycling, and composting were prioritized. The concept of a circular economy began to emerge from 1985 onwards.

It was not until 1990 that Pearce and Turner formally introduced the term "circular economy." Research on the circular economy has been developed by various aproaches, such as regenerative design, performance economy, industrial ecology, green economy, natural capitalism, industrial transformation, and industrial symbiosis. These schools complement each other and provide the foundation for the core principles of this new approach to the economy, as evidenced by the work of Joustra, de Jong, and Engelaer (2013); Sariatli (2017); Kalmykova, Sadagopan, and Rosado (2018).

Kirchherr, Reike, and Hekkert (2017) reviewed 114 definitions of the circular economy, analyzing the content across 17 different dimensions, and found that the circular economy is primarily understood as a combination of reduction, reuse, and recycling activities, thereby increasing economic prosperity, protecting the environment, and improving resource management. In terms of content, interpretations range from the simple notion of reducing emissions to more complex concepts such as 3R, 4R, 6R, and 9R. Thus, the circular economy is viewed and studied from various perspectives and levels. Many definitions focus on waste management and resource conservation in production and consumption models. In general, a circular economy model has three fundamental principles: (i) maintaining and developing natural capital; (ii) optimizing the use of natural resources; and (iii) improving the overall system performance (UNEP, 2011; Ellen MacArthur Foundation, 2019; Nguyen Hoang Nam & Nguyen Trong Hanh, 2019; Nguyen Dinh Dap, 2021).

Vietnam defines the circular economy in Article 142 of the Environmental Protection Law of 2020 as "an economic model in which design, production, consumption, and service activities aim to reduce the exploitation of raw materials, prolong the life cycle of products, limit waste generation, and minimize negative impacts on the environment." This concept emphasizes the exploitation and efficient use of resources in production and business activities, and minimizing waste to protect the environment.

The circular economy principles for waste management

The principle of circular economy is that everything discharged from this production and business process is an input for other production and business processes, better exploiting important resources contained in obsolete products, and minimizing the amount of waste released into the environment. According to Stahel, W (2016), the circular economy aims to maximize value at each stage in the life cycle of a product, in which everything generated during the production process is utilized through classification, reuse, recycling, repair, restoration, refurbishment, redesign of products, utilities... Bilitewski, B (2012) also shows that the waste management system is focused on as a main pillar in the circular economy. Applying circular economy principles is to overcome inefficient waste management, by highlighting to managers the benefits that new business models can bring (Rosa et al., 2019). Identifying circular economy models is a good practice to address climate change, by facilitating supply chain resilience, (Appolloni et al., 2021).

Currently, many waste management patterns (models) are being implemented based on circular economy principles. Specifically:

The 3R model that includes reduce, reuse and recycle

+ Reduce: Reducing household waste is often done through measures to encourage behavioral change, build an environmentally friendly lifestyle, save water and energy, ... towards sustainable consumption. Reducing industrial waste generation is mainly focused on applying cleaner production technology.

+ Reuse: Reuse is a form of waste reduction, such as encouraging product reuse services (repair, rental); increasing and encouraging the production of product components with a high average life, or continuing to use the product but for a different function.

+ Recycle: Recycling can be in the form of regeneration or regenerating value or continuing to exploit value. In the recycling process, it is important to pay attention to the regenerative properties of materials and fuels, accordingly distinguishing between renewable materials and fuels and non-renewable materials and fuels.

The 4R model: reduce waste, reuse, recover, and recycle. The content of recovers/refurbishes is a new option, appearing before remanufacturing and reconditioning, which may be most suitable in cases where the overall structure of a product is still largely intact.

The 5R model is supplemented with changing thinking, thinking about maintaining the ecosystem (rethink), that means this model has 5 contents: reduce waste, reuse, recycle, recover, and change thinking.

The 6R model provides a closed life cycle system including reduce, reuse, recover, recycle, redesign, and remanufacture.

+ Recover: is the process of collecting products at the end of the use stage, the product is disassembled, classified and cleaned for use in the next life cycles of the product.

+ Re-design: is the activity of redesigning the next products, using components and materials recovered from the previous life cycle or previous product generation.

+ Re-manufacture: is the recycling of used products to restore them to their original state or a new form by reusing as many parts as possible without losing their function.

The 7R model is developed based on the 5R model, which includes reduce, reuse, recycle, recover, refuse, repair, replace.

+ Refuse: is the rejection of technologies, raw materials and products that have negative impacts on the environment, single-use products that cannot be recycled and resource-circulating, products with packaging made of materials that are not environmentally friendly.

+ Repair: to reuse products or parts that can be used to extend the life of the product, reduce waste, save costs and resources,

+ Replace: replace environmentally unfriendly products and parts with environmentally friendly products and parts at any stage possible.

The R9 model is expanded from the 7R model, adding: energy recovery and re-exploitation.

+ Recover energy: Energy recovery is the collection of used products at the end of their life, then disassembling, sorting and cleaning for recycling.

+ Re-exploitation (R9): is the recovery of materials after the landfill stage or the retrieval of valuable parts from discarded products.

Reike et al. (2018) continued to mention the 10R model that contains: (1) R0: Refuse; (2) R1: Reduce; (3) R2: Rethink; (4) R3: Repair; (5) R4: Refurbish; (6) R5: Remanufacture; (7) R6: Repurpose/reuse; (8) R7: Recycle), (9) R8: Recover; (10) R9: Re-exploitation, and Morseletto (2020) organizes the ideas of 10R into three groups: (1) the use of useful materials; (2) the extension of the life of products and their components; (3) the production and use of products more intelligently.

2. Experience in waste treatment in the production and consumption of some countries

* *European countries*

In 2015, the European Commission adopted the Circular Economy Action Plan, which includes measures to promote Europe's transition to a circular economy, increase global competitiveness, promote sustainable economic growth, and create new jobs. The EU's Circular Economy Action Plan has established a specific and comprehensive action program from production, and consumption to waste management, to secondary raw material markets and proposed regulations to amend waste legislation.

Evidence for the implementation of the circular economy in Europe is numerous and diverse. For example, the Michelin tire manufacturing group has successfully applied the circular economy model with the 4R strategy: reduce, reuse, recycle and renew. They have reduced CO2 emissions by adopting eco-design, collecting all used tires for recycling, reusing energy and waste from production and end-of-life tires, and incorporating renewable materials into the production of new tires. Since 2007, Michelin has been selling “per-mile” tire rights to fleet operators. The company has developed a system of mobile workshops to repair and refurbish tires at customer locations and aims to develop products with longer lifespans. Used tires are sent to Michelin factories for remolding and reuse. Swiss company Elite has adopted a similar strategy with hotel carpets. Schneider Electric, a French-based energy management and automation group with more than 142,000 employees in more than 100 countries, uses recycled materials in its products; extend the life of products by renting and paying per use, and have a plan to buy back products after use into their supply chain. In the UK, the startup Winnow has developed a new type of smart meter that measures the amount of food thrown away in industrial kitchens and seeks to reduce it. When controlling in kitchens, up to 1/5 of the food purchased is often wasted. Winnow has managed and reduced 50% of waste in hundreds of kitchens in 40 countries, saving customers more than 25 million dollars per year (According to Nguyen Dinh Dap, 2021).

Sweden is the world's leading country in waste management and recycling since the mid-90s of the 20th century. Sweden strives to not use fossil fuels by 2040, moving towards a zero-waste society. Therefore, the circular economy is considered the key to achieving the above goals. Sweden's experience in implementing a circular economy begins with changing the mindset of production and consumption, making plans and applying science and technology to waste treatment industries, with the cooperation of the State, people and businesses. Sweden has established advisory groups on the circular economy to help the Government support people and businesses, and at the same time research on waste and the environment. The purpose of this is to unify the mindset of developing a circular economy nationwide; innovate production processes in businesses; apply clean technology in the production process towards a "zero waste future"; build a circular economy for each specific industry. In the food industry: certified paper boxes

are used as carton packaging. In addition, beverage businesses use paper straws for beverage products. In the plastics industry: 53% of consumer plastics are recycled. In addition, Sweden is making efforts to tighten targets on production, consumption and plastic waste. In the manufacturing industry: Swedish manufacturing enterprises are increasingly applying science and technology in the production process to minimize the amount of waste released into the environment. The construction industry is the industry that emits the most emissions and has the most serious impact on the environment. However, currently only about 50% of construction waste is recycled; Recycling waste into electricity, with 99% of household waste and millions of tons of imported waste each year being recycled into electricity. To do this, Sweden has applied many measures such as: regulating waste recycling locations, sorting waste by bag color, imposing high taxes on the use of fossil fuels and switching to renewable energy[2].

The EU has issued the Ecodesign Directive (Ecodesign – Directive 2009/125/EC). Currently, the Ecodesign product design requirements are mainly aimed at energy efficiency. Under the Ecodesign Directive, there are mandatory product design and marking requirements of the Member States to make it easier and safer to reuse and recycle electronic displays (e.g. flat panel computers or television screens). The EU issues Base Technical Documents (BATs) for many industrial sectors to promote better waste management. In addition, through a series of activities such as: establishing the European Resource Efficient Production Center, implementing the EU Eco-Management and Audit Scheme (EMAS) and the Environmental Technology Verification Pilot Programme (ETV), small and medium-sized enterprises have benefited from the efficient use of resources in production (According to the Ministry of Natural Resources and Environment of Vietnam, 2019).

Since 2015, the EU has proposed an improved labeling system for the energy efficiency of household appliances and other energy-related products to help consumers choose the most efficient products. The labeling system allows consumers to be shown information about the durability of energy-related products. The price of goods is an important factor influencing purchasing decisions, so Member States are encouraged to provide incentives and use economic instruments (such as taxes) to ensure that product prices better reflect environmental costs. Innovative forms of consumption can also support the development of a circular economy, such as product or infrastructure sharing. These new forms of consumption are often developed by businesses and promoted at national, regional and local levels. Support for these new business and consumption models is provided through Horizon 2020 and through policy-linked funding (According to the Ministry of Natural Resources and Environment of Vietnam, 2019).

**** United States***

The United States also has hundreds of initiatives related to the use and management of recycled materials by companies in the direction of circular economy. Most companies realize that they can save money if they reuse scrap materials in the factory instead of throwing them away. However, many companies are still in the early stages of understanding and applying the circular economy. Some typical examples of circular economy applications in the US include: EcoVolt technology of the American company Cambrian Innovation, which not only treats polluted wastewater from industrial activities into clean water but also creates biogas (such as Methane) to produce clean energy. The company currently has 9 factories in the US and treats about 300 million liters of wastewater; Lehigh Technologies turns old tires and rubber waste into micronized rubber powder (MRP), which has many applications from making tires to producing plastics, asphalt, and construction materials. HYLA Mobile works with many of the world's leading manufacturers and service providers to repurpose or reuse discarded smartphone and tablet devices and components. It is estimated that the company has reused more than 50 million devices, generating $4 billion for owners and preventing 6,500 tons of e-waste from ending up in landfills. Urban Mining, a Texas-based company, has developed a process to recycle Neodymium Iron Boron (NdFeB) magnets, a widely used type of magnet found in products such as cordless drills, hard drives, and electric motors. The company's products are made from recycled materials from end-of-life products; Niaga developed a carpet material that can be completely restored to its original form efficiently. In the post-use phase, the carpet is collected and all other materials can be recovered to be incorporated into a new carpet. The carpets are made from pure polyester, or a double blend of polyester and polyamide, polypropylene or wool. In this case, the two layers are bonded together with an adhesive and they can be easily separated after use. Implementing an overall design that can capture the value of the material after it is used and in the next stage of use will help reduce production costs, (FZJ, J. F. R., Hahn, C., Repen, B., Echeverría, E., Dontschev, M., Manoochehri, S., ... & Su, S, 2020)

The United States also has many models that encourage a circular economy based on the market rather than government guidelines and directives. A good example of this approach is the e-waste market in the State of Colorado. Specifically, in 2013, in the state of Colorado, when the landfill of electronic waste was banned, businesses immediately emerged to collect and recycle electronic waste. Thus, a market with buyers being households and sellers being service providers. The result is that the environment is protected, creating more jobs for society. The state does not have to pay for the treatment of pollution caused by electronic waste while the waste is circulated and reused. Similar markets are continuously being formed, making waste collection and treatment in the US a vibrant and highly profitable field for investors. Several US cities have also developed and enacted a "Zero waste" strategy to have no waste released into the environment by 2030. Cities will have to change from the current cost-based approach to a resource management-based approach, by considering waste as an asset that needs to be managed, rather than just a legal responsibility. From

[2] https://sti.vista.gov.vn/tw/Lists/TaiLieuKHCN/Attachments/325807/CVv219S3082021117.pdf.

there, the roadmaps are linked to very specific policies such as: promoting public-private partnerships, food waste management, wastewater collection and treatment, construction waste recycling, establishing facilities for donation and recycling, etc. (According to Nguyen Hoan Nam and Nguyen Trong Hanh, 2019).

**** Asian countries***

China

The Chinese government has been aware of the inefficient exploitation of resources and the consequences of the linear economy since early on. Therefore, in the 1990s, Chinese scholars proposed a circular economy model to help China make better use of resources and energy. The fourth meeting of the Standing Committee of the National People's Congress of the People's Republic of China on August 29, 2008, officially passed the Circular Economy Promotion Law, which took effect on January 1, 2009, marking China's first step in creating a legal foundation for the circular economy. The law consists of 7 chapters and 57 articles, of which Chapter IV focuses on the provisions on "Resource Recycling and Recovery"; Chapter V focuses on the provisions on "Incentive Measures"; Chapter VI focuses on the provisions on "Legal Responsibilities"[3].

The targets are issued for the coal, steel, electronics, chemical and petrochemical industries. According to this law, any new industrial policy created by the government must meet the criteria for promoting a circular economy. Industries must implement management systems to reduce resource use and waste generation, and improve resource recovery and recycling. This law stipulates the principles of circular economy development, according to which the development of a circular economy must adhere to the prerequisite principles of being technically feasible, economically reasonable and resource-saving. In the process of reusing and recycling waste, production safety must be ensured so that product quality meets national standards and secondary pollution is prevented. Since then, the circular economy has become an indispensable part of the national economic strategy and has been formulated in many of China's Five-Year Plans. Specifically, China's 11th Five-Year Plan (2006-2010) devoted a chapter to the circular economy. The circular economy was then upgraded to a national development strategy in the 12th Five-Year Plan (2011-2015) with goals including: reusing 72% of ordinary solid waste by 2015 and raising resource productivity (economic output per unit of resource used) by 15%. Results over the past decade show that China has been at the top of the world in promoting waste recycling, reducing raw material consumption and reducing waste generation. A typical example of electronic circuit board production in Suzhou district shows that instead of using pure copper produced by mining companies, electronic circuit board manufacturers have used copper recovered from waste elsewhere in the industrial park. Another example is a kaolin manufacturing company, which turned the residue from mining into an input for the production of sulfuric acid and construction materials (Mathews, J. A., & Tan, H, 2016).

Korea

The 1992 Act on the Promotion of Resource Conservation and Recycling of Korea, amended in 2008, provides a framework for waste recycling, such as a basic recycling plan, the roles and responsibilities of businesses and citizens in promoting waste recycling, and provisions related to waste reduction. The basis of this law is waste reduction, including: (i) a volume-based fee system for households and small businesses; (ii) restrictions on the use of disposable products by businesses; and (iii) restrictions on the use of packaging materials that are difficult to recycle. The Act provides for the resource recycling of vehicles, electrical and electronic products to promote the recycling of waste from electrical and electronic equipment; and prescribes recycling obligations for manufacturers and importers of vehicles and electrical goods; provides a framework for waste recycling, emphasizing the roles and responsibilities of businesses and citizens in promoting waste recycling, and provisions related to waste reduction. In 2010, the Korean government announced the Volume-Based Food Waste Disposal Fee System. Under the volume-based fee scheme, households are required to pay based on the amount of food waste generated. Direct landfilling of food waste has been banned since 2005.

Waste management in Korea is similar to Japan, but solid waste treatment is somewhat different. Part of organic solid waste in the kitchen is used as a substrate for growing edible mushrooms, while the larger part is buried in a controlled manner to recover biogas for power generation. After the solid waste in the landfill is completely decomposed, the humus in the landfill is exploited as fertilizer. Thus, in developed countries, the classification of solid waste at source has been carried out about 30 years ago and has been basically successful in separating solid waste into two streams: easily decomposable organic waste, collected and treated daily; hard-to-decompose solid waste can be recycled or burned, safely buried, and collected weekly (According to the Ministry of Natural Resources and Environment of Vietnam, 2019)

In 2013, the Korean Government officially issued a law on food waste disposal, which stipulates waste collection standards. Specifically, waste is put into biodegradable bags or put directly into metal bins equipped with measuring bars and radio frequency identification chip readers. This law also stipulates that people will have to pay extra if the amount of waste exceeds the permitted volume and 60% of that amount is used by the Government to pay for the collection and treatment of waste generated. This law has

[3] https://www.greengrowthknowledge.org/sites/default/files/downloads/policy database/CHINA%29%20Circular%20Economy%20Promotion%20Law%20%282008%29.pdf

now helped 95% of food waste in Korea to be recycled into organic fertilizer, animal feed or fertilizer, and the remaining liquid after being pressed from waste is fermented into gas or bio-oil for further use. This is a closed cycle from collection, processing to recycling products in a "symbiotic" form (According to Nguyen Dinh Dap, 2021). In 2017, Korea issued the Resource Circulation Law and this Law took effect in early 2018. The Law provides regulations on: identifying circular resources, managing resource circulatory efficiency, assessing the availability of circulatory cycles and waste treatment fees. In addition, this Law also provides regulations on reducing waste in all processes from production, distribution, consumption to product treatment and to promote recycling (According to Nguyen Hoang Nam and Nguyen Trong Hanh, 2019).

Singapore

Singapore is an early example in Asia of promoting a circular economy. By adopting a circular economy approach to close the resource loop of food waste, e-waste and packaging waste, including plastics, Singapore is moving towards a "zero waste" future – where households and industries consume less, waste less and recycle more. To provide clear direction for waste management and in the face of environmental challenges from climate change and increasing waste sources, Singapore has launched a zero waste master plan with specific targets such as: a 30% reduction in waste sent to landfill by 2035 and an overall recycling rate of 70% (81% non-domestic recycling and 30% domestic recycling). The key drivers for action under the Zero Waste Master Plan are identified as follows: (i) First, developing the frontier through research and infrastructure; (ii) Second, transforming the environmental services sector; (iii) Thirdly, co-creating solutions with the community[4].

In its journey towards a zero-waste nation, Singapore is focusing on closing the three resource loops for waste from food, electrical and electronic equipment, and packaging, including plastics. Singapore has achieved some successes such as a near 100% recycling rate for construction and demolition waste and metals. However, there are some types of waste that are generated in large quantities but have low recycling rates, such as food and packaging. For electrical and electronic waste (e-waste), although it accounts for less than 1% of the total waste generated in Singapore, it can have a negative impact on the environment if not managed properly. Therefore, food waste, e-waste, and packaging, including plastics, are the three waste streams that Singapore prioritizes to manage to close the resource loop, aiming to become a zero-waste nation. The Singapore government has supported the proper management of these three priority waste streams through a regulatory framework that promotes resource sustainability. The Resource Sustainability Act, a landmark piece of legislation introduced in 2019, gives effect to the regulatory framework. Through the legislation, the government will require the segregation and disposal of food waste at large food waste generators and extend the "Producer Responsibility Framework" (EPR) to manufacturers and retailers of electrical and electronic equipment. It will also require them to report packaging data and submit plans to reduce, reuse or recycle packaging from packaged product manufacturers and supermarkets.

Singapore is implementing an on-site food waste management system. Treat food waste as a valuable resource, by converting food waste into a (non-drinkable) liquid nutrient or compost from waste. To kick-start the implementation of such systems, in 2016, the National Environment Agency (NEA) - under the Ministry of Sustainability and Environment was authorized by the Singapore government to implement a pilot project at a hawker centre, with the active participation and support of stall owners and cleaning staff, which made the project a success. This system continued to be widely deployed at several other hawker centres. In addition to exploiting useful by-products from food waste, the project's food waste recycling can also save money. Therefore, the project has implemented the treatment of food waste into organic fertilizer, distributed to members of the community at the end of each month. Singapore has saved about $40,000 annually from reduced daily waste disposal fees, as food waste is no longer treated as regular waste.

In addition, participating organizations are continuing to pilot food waste-to-energy at a water reclamation plant, where food waste is segregated at source from regular waste and placed in food waste bins. The resulting food waste is mixed with used water sludge, undergoing a co-digestion process to form a source of biogas, which can triple the biogas yield compared to just digesting used water sludge, thereby increasing energy production. By August 2018, households in the project area were provided with information on how to separate their food waste, as well as food waste containers and bags to collect their food waste. Residents are required to bag their food waste and deposit it in the food waste recycling bins located at their premises. This food waste is collected back to the project site for further processing (Ministry of Environment and Water Resources; and National Environment Agency of Singapore)[5].

3. Some lessons learned for Vietnam

The first is to perfect the system of policies and laws to promote the development of a circular economy. Develop a national legal framework on resource circulation for industries and fields; develop mechanisms, policies, and framework regulations on promoting waste

[4] https://www.expertisefrance.fr/documents/20182/778216/Circular+Economy+in+Singapore+-+Comparative+Policy+Study+EU-Singapore/3665a220-9ae1-49e5-b214-0a747bad0b05.
[5] https://www.towardszerowaste.gov.sg/zero-waste-masterplan/chapter3/food/.

recycling, on the roles and responsibilities of producers (EPR) and people in enhancing recycling to promote resource-saving and sustainable environmental protection. Develop a system of fees for waste collection and treatment that is appropriate to the actual amount of waste generated and its adverse impact on the environment. Develop basic operating principles for waste management according to the philosophy of a circular economy - closing the product cycle, with no waste released into the environment.

The second is to promote the development of a recycling and reuse market for activities that link the supply and use of raw materials for production inputs, replacing raw materials exploited from natural sources; There is a policy mechanism to strongly promote the consumption of recycled products with green labels and distinctive logos... implementing green consumption from green public procurement by the state to consumer consumption.

The third is to develop the waste treatment industry, build a mechanism to control the transportation, collection, and treatment of waste types, promote the reduction of landfill and incineration, consider waste as a resource, and enhance the treatment and conversion of solid waste into energy sources to continue serving the production process.

The fourth is to apply advanced technology, promote digital transformation, and build a database on waste management and environmental protection.

The fifth is to focus on supporting preferential credit sources for investment in facilities and appropriate technology for projects and models of effective treatment of domestic solid waste, for solid waste management to protect the environment, especially from socialized sources and international cooperation sources.

The sixth is to promote propaganda, and education, raise awareness, and strongly promote typical models of waste management and recycling.

4. Current status of waste management in Vietnam

Approaching the circular economy in Vietnam

The circular economy in Vietnam is still a new approach and still faces many obstacles. The reason is that most Vietnamese enterprises lack resources and technological capacity to convert to a circular economy model; it is difficult to immediately change production and consumption habits; waste classification at source has not been well implemented and the collection and reuse market has not yet developed; human resources with a good understanding of the circular economy (clearly understanding the characteristics of production from the beginning to the end) are still limited; the institutional framework for developing the circular economy is not yet complete, there is a lack of policies to promote the development of the circular economy, the brown economy still helps stabilize budget revenue and stabilize the economy. According to research by Dinh Thao Hoa & Nguyen Hong Long (2018), 78% of business managers do not know the concept of the Circular Economy; 13.3% know the concept of sustainable production and consumption, efficient use of resources, but have not taken many actions to implement it; 62% of businesses believe that their products have more than 40% of materials that can be recycled after use and 2% can be renewed; 75% of businesses have never purchased recycled materials; 80% of businesses do not know of any recycling facilities that have materials that meet production needs; 75% of businesses have never cooperated with a professional waste treatment business to find solutions for waste use.

According to a report by the Ministry of Natural Resources and Environment of Vietnam, each year the total amount of domestic solid waste in Vietnam is 25 million tons, but only 30% is treated by incineration or organic fertilizer production, 70% is buried directly. In the period of 2016 - 2020, the amount of domestic solid waste continues to increase. Domestic waste generated from urban areas in general increases by an average of 10% - 16% per year and increases sharply in large cities. The total volume of solid waste generated in urban areas nationwide in 2019 was about 13 million tons. However, the average waste collection rate in urban areas nationwide was only about 70% - 85% (Ngoc Diep, 2023). Industrial solid waste is mainly generated from industrial production facilities located inside and outside industrial parks, export processing zones, and high-tech zones with a volume of about 25 million tons/year; industrial solid waste generated from craft villages is about 17 tons/day; other common industrial waste such as soil and rock removed from coal and mineral mining in 2018 is about 165 million m3; Hazardous waste from industrial activities in 2019 was about 1,100 tons, an increase compared to 2018. Solid waste generated in 2019 in rural areas was about 10 million tons, of which about 400,000 kg of packages and bottles containing pesticides (only 79% destroyed); solid waste generated from livestock was about 90 million tons and from crop by-products was about 95 million tons. Medical solid waste generated in 2019 was about 96 thousand tons, of which hazardous medical waste was about 24 thousand tons/year. The current situation of plastic waste pollution in Vietnam is very serious for the environment. The amount of plastic waste and nylon bags increases gradually every year. Vietnam's 2022 plastic waste status report shows that the volume of plastic waste generated is 2.9 million tons/year, of which the volume of plastic waste generated in urban areas is 1.6 million tons and 1.3 million tons in rural areas. In 2020, Vietnam had 1,322 facilities for treating domestic solid waste, including: 381 incinerators, many of which do not meet technical standards, a few facilities apply the method of burning to recover energy and generate electricity, 37 compost processing lines, 904 landfills, many of which are illegal. Local incinerators are always overloaded with design capacity for the amount of waste generated daily. Landfills in many localities are also limited in scale, many are spontaneous household waste dumps from people, due to lack of concentrated sites, lack of vehicles to transport to the collection point, causing pollution to the living environment of people.

Difficulties in environmental waste management in Vietnam

Many provinces and cities in Vietnam have achieved a solid waste collection rate of over 90% to 100%. However, solid waste is currently collected at home or at landfills without classification (Pham Thi Thanh Binh et al., 2022), and solid waste collection facilities are lacking, rudimentary, and unhygienic (Tran Thu Huong, 2019). Many people do not have a good awareness of the role and significance of the need to sort waste at the source. The units that collect and transport all types of waste from households and residential areas to landfills do not classify them separately for recycling, reuse, production into fertilizers, or energy recovery... Although many households have collected recyclable household solid waste separately, packaged it and sold it to scrap buyers, from there it is transferred to recycling production facilities. People are also concerned that sorting household solid waste will be costly or a waste of time. For example, in the case of Hanoi, more than 87% of people think that there is no need to sort waste because sorting takes time. Moreover, if people finish sorting, the collectors still put all types of waste together, so sorting is almost meaningless. In addition, many households do not have the habit of accumulating garbage in their homes, often throwing garbage out on the roadside, or leaving it in the area next to their house without waiting for the garbage collector to come and take it away.

Landfills also face many difficulties in expanding their scale, due to lack of support from the people. Most localities in Vietnam have not yet selected suitable technology for treating domestic solid waste, causing a waste of investment resources and very limited efficiency in treating domestic solid waste, always in a state of overload. There are no complete instructions on technological solutions for treating domestic waste for localities to develop appropriate options. There has not been a national unit price for each treatment method (landfill, conventional incineration without electricity generation, incineration for electricity generation, etc.).

The process and procedures for investing in advanced waste treatment technology are still complicated, such as waste incineration for electricity generation, and there are many overlaps in related legal regulations.

5. Some policy implications for Vietnam

Regarding policymakers and management organisations

Vietnam has officially included the circular economy in the 2020 Law on Environmental Protection. However, it is necessary to continue to develop concrete plans, and goals, and monitor indicators to promote the circular economy development roadmap following domestic development conditions and the general development context of the world.

Vietnam needs to have the following measures:

- Continue to supplement and perfect the legal framework on sustainable resource management; develop policies to support the implementation of models/approaches and operation of advanced technology systems to effectively treat waste, creating a resource loop for a zero-waste roadmap in the future.
- Develop and apply regulations and operating principles for waste management and treatment and must be implemented in compliance with the economic development process, along with environmental protection, with the integration of the whole society, the cooperation of companies, factories, awareness and cooperation of the community.
- Have policies to support manufacturing enterprises to shift to new business models, produce sustainable products, both protect the environment and create new economic benefits, in which the transformation needs to be designed from the beginning, strongly promoting the recycling linkage policy mechanism, to minimize and aim for zero waste to the environment, creating a closed loop of resources.
- Develop overall strategies/plans, specific actions on zero waste implementation; Applying the operating principles from 3R, 4R, 5R…10R to manage waste in areas suitable to the current situation and the roadmap being built, by comprehensively and effectively approaching resources to build clear directions on waste management, ensuring resources are used multiple times, minimizing waste sources that are harmful to the environment.
- Develop specific regulations and strict sanctions on waste classification before discharging it outside; implementing an effective waste treatment and recycling process; reducing greenhouse gas emissions from production and reducing emissions from waste incineration will help minimize the impact of climate change.
- Strengthen cooperation with countries on policy exchange, research, seminars, transfer of advanced technology, experience in implementing projects/models in practice, etc. to protect natural resources and the environment.
- Build complete information data on models to reduce, reuse, and recycle waste for a sustainable environment; promote communication to raise awareness among businesses and communities, and attach responsibility for waste generated from production and business activities.
- Have appropriate spatial planning for on-site waste treatment (new waste recycling infrastructure, collection bins/tanks, sorting equipment, storage space, etc.) and ensure the health and safety of the community.

Regarding production

Companies and businesses need to be aware of the benefits of the circular economic model early on to develop plans, roadmaps, and solutions to effectively transition to this new production and business model. Right from the beginning of the production and business process, it is necessary to develop a technical design to ensure energy savings, product recyclability, sustainability, and environmental protection.

It is necessary to apply advanced and appropriate technologies to implement effective solutions to waste problems, in order to prolong the use of final products and ensure the efficient use of natural resources.

It is necessary to ensure sufficient resources and creativity in implementing waste reduction and enhancing the ability to recycle waste. The process of minimizing toxic waste released into the environment needs to be designed right from the production stage, including packaging or product design.

Regarding consumption

There should be various forms of propaganda and communication to change the mindset about economic food use; raise awareness and create motivation to reduce waste in the use of consumer food. Enhance the role and responsibility of relevant parties in reducing food waste released into the environment. Develop guidelines on implementing economical food consumption from the family to the public.

Propaganda, communication, application of many types of encouragement and support so that consumers use less/no packaging in consumption/use recycled packaging; encourage households to recycle themselves; build a recycling culture by encouraging households to raise awareness and implement proper recycling methods.

REFERENCES

1. Appolloni, A., D'Adamo, I., Gastaldi, M., Santibanez-Gonzalez, E. D., & Settembre-Blundo, D. (2021). Growing e-waste management risk awareness points towards new recycling scenarios: The view of the Big Four's youngest consultants. *Environmental Technology & Innovation*, *23*, 101716.
2. Bilitewski, B., 2012. The circular economy and its risks. Waste Manag. 32, 1– https:// doi.org/10.1016/j.wasman.2011.10.004.
3. Ministry of Natural Resources and Environment of Vietnam. (2020). National State of the Environment Report 2019.
4. Ministry of Natural Resources and Environment of Vietnam. (2021). National State of the Environment Report 2016 – 2020.
5. Hoa, D. T., & Long, N. H. (2018). An assessment of vietnamese firms' readiness to adopt a circular economy. *Industry 4.0: Empowering ASEAN for the circular economy*, *1995*(2000), 161.
6. Ellen MacArthur Foundation. (2013). Towards the circular economy: Economic and business rationale for an accelerated transition. *Journal of Industrial Ecology*, *2*(1), 23–44.
7. Ellen MacArthur Foundation. (2019). *Cities and Circular Economy for Food*. https://ellenmacarthurfoundation.org/publications.
8. FZJ, J. F. R., Hahn, C., Repen, B., Echeverría, E., Dontschev, M., Manoochehri, S., ... & Su, S. (2020). Report on experiences with the implementation of Circular Economy outside Europe.
9. Geissdoerfer, M., Savaget, P., Bocken, NM, & Hultink, EJ. (2017). The Circular Economy: A review of definitions, processes and impacts. CEPS Research Report No 2017/8, April 2017.
10. Ghosh, S. K. (2019). Circular Economy : Global Perspective. https://doi.org/10.1007/978-981-15-1052-6.
11. Joustra, D. J., de Jong, E., & Engelaer, F. (2013). *Guided choices: towards a circular business model*. C2C BIZZ. https://www.greencycle.si/wp-content/uploads/2018/03/guided_choices_towards_a_circular_business_model.pdf.
12. Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: Ananalysis of 114 definitions. Resources, Conservation and Recycling, 127(April), 221–232.
13. Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: the concept and its limitations. *Ecological economics*, *143*, 37-46.
14. Mathews, J. A., & Tan, H. (2016). Circular economy: lessons from China. Nature News, 531(7595), 440.
15. Morseletto, P. (2020). A new framework for policy evaluation: Targets, marine litter, Italy and the Marine Strategy Framework Directive. *Marine Policy*, *117*, 103956.
16. Diep, N. (2023). Environmental pollution from household waste. https://www.tapchicongsan.org.vn/web/guest/gop-y-du-thao-cac-van-kien-trinh-dai-hoi-xiii-cua-dang/-/2018/824338/view_content#.
17. Dap, N. D. (2021): Circular Economy: Theoretical and Practical Issues. http://tapchinganhang.gov.vn/kinh-te-tuan-hoan-nhung-van-de-ly-luan-va-thuc-tien.htm
18. Nam, N. H., & Hanh, N. T. (2019). Implementing Circular Economy: International experience and policy implications for Vietnam. *VNU JOURNAL OF ECONOMICS AND BUSINESS*, *35*(4).
19. Pearce, D., & Turner, R. K. (1990). Economics of natural resources and the environment. Johns Hopkins University Press. Baltimore
20. Bình, P. T. T., Luân, M. T., & Vân, N. T. (2022). Assessing the current situation and proposing a model for classifying and treating household waste in Yen Dinh district, Thanh Hoa province. *Hong Duc University Journal of Science, (62), 7-16.*

21. Reike, D., Vermeulen, W. J., & Witjes, S. (2018). The circular economy: new or refurbished as CE 3.0?—exploring controversies in the conceptualization of the circular economy through a focus on history and resource value retention options. *Resources, conservation and recycling*, *135*, 246-264.
22. Rizos, V., Tuokko, K., Behrens, A. (2017). The Circular Economy: A review of definitions, processes and impacts. CEPS Research Report No 2017/8, April 2017.
23. Rosa, P., Sassanelli, C., & Terzi, S. (2019). Towards Circular Business Models: A systematic literature review on classification frameworks and archetypes. *Journal of cleaner production*, *236*, 117696.
24. Stahel, W. R. (2016). The circular economy. *Nature*, *531*(7595), 435-438.
25. Huong, T. T. (2019). Research on the current status of plastic waste in Vietnam. WWF project documents and research.
26. UNEP. (2011). "Toward a Green Economy: Pathways to Sustainable development and poverty eradication". www.unep.org/greeneconomy
27. UNIDO. (2017). Circular Economy. Vienna, Austria. https://www.unido.org/sites/default/files/2017- 07/Circular_Economy_UNIDO_0.pdf/, 2017.
28. https://sti.vista.gov.vn/tw/Lists/TaiLieuKHCN/Attachments/325807/CVv219S3082021117.pdf
29. https://www.expertisefrance.fr/documents/20182/778216/Circular+Economy+in+Singapore+-+Comparative+Policy+Study+EU-Singapore/3665a220-9ae1-49e5-b214-0a747bad0b05
30. https://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/CHINA%29%20Circular%20Economy%20Promotion%20Law%20%282008%29.pdf
31. https://www.towardszerowaste.gov.sg/zero-waste-masterplan/chapter3/food/
32. https://pcd.monre.gov.vn/quan-ly-chat-thai/5745/ap-luc-ve-van-de-xu-ly-rac-thai-sinh-hoat-o-nuoc-ta-hien-nay