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Review of the Circular Economy of Plastic Waste in Various Countries and Potential Applications in Indonesia

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Abstract. One of the main environmental problems faced by the world, including Indonesia, is plastic waste. Plastic waste has polluted the soil, rivers, and the sea. The nature of plastic that is not easily biodegradable, takes hundreds of years to decompose naturally. Plastic waste management which is believed to be effective, in addition to efforts to reduce use is by recycling plastic waste. In many countries, recycling plastic waste has led to a circular economy. This circular system allows plastic waste to be recycled into new products. In fact, this concept is claimed to be able to encourage environmentally friendly economic growth. This study uses a literature study to identify the application of a circular economy of plastic waste in various countries. As a result, 21 papers were collected and analyzed based on year of publication, geographical location and research methodology. Furthermore, this study highlights the obstacles faced by many countries towards a circular economy followed by a comparison of their plastic waste recycling rate achievements. This research also discusses the state of plastic waste management and the potential for adoption of circular economy best practices in Indonesia.

1. Introduction

Plastic waste is one of the environmental polluter issues, both as a pollutant of the soil and the sea. The nature of plastic waste that is not easily decomposed or takes hundreds of years to decompose, as well as processing processes that are toxic and carcinogenic, make it a worrying environmental pollutant. So that the existence of plastic which was originally intended to help preserve the environment due to the exploitation of paper as a wrapping material, in its development became a challenge, especially in terms of waste management.

The United States (US) is by far the largest contributor to plastic waste in the world, generating 35.7 million tons of plastic waste in 2018, more than the 29 million tons of European countries and 26.7 million tons of China[1].

The circular economy is a concept that promotes the repair, improvement and redistribution of second-hand goods. Circular economy is basically an idea, which drives the change of a linear process into a circular process, which involves reduction, reuse, recycling, arrangement, assembly and circulation[2]. The principle of circular economy is theoretically divided into 3Rs, namely "Reduce, Reuse, Recycle"[3]. Through the circulation economy model, it is hoped that it will be able to extend the life of the waste into something useful to be reused. Plastic waste as an alternative raw material or



recycled into new products, so it can save production costs or become new products that sell well. Various policies have been adopted by various countries to achieve this circular economy.

To move towards a more circular economy, in 2015 the European Commission proposed the first Circular Economy Package and continued with the Second Circular Economy Package in 2018[4]. The plan sets out a concrete program of action and measures to stimulate Europe's transition to a circular economy. In Indonesia, plastic waste accounts for 15% of the total waste and is still not managed properly even though various policies have been issued[5].

In this study, a literature review was conducted on the application of the circular economy in various countries in the world. Various articles related to the circular economy were collected and then identified various obstacles faced, policies and methods used to increase the recycling rate. The results of this compilation are used as adoption for the Indonesian state which methods and methods are suitable and suitable to be applied. The first part tells about the introduction related to plastic waste. The second part describes the research methods used. The third section describes the results of data processing. The fourth part is a discussion that tells how to handle plastic waste in Indonesia and the adoption of a circular economy and the last part contains the conclusions of this research.

2. Methodology

To study how the circular economy concept is actively applied in various countries, a literature review of existing scientific publications is carried out. This methodology section describes how data was collected, analyzed and presented in this article. The first stage is to identify the search criteria. The second stage is to search for suitable papers based on the title and abstract. The third stage is to determine the paper that will be taken more deeply, including reading the contents and conclusions until the final number is obtained. The final step is to describe the collected papers with the parameters of the year of publication, research methodology, geographic location, barriers, methods and policies as well as the recycling rate in the country.

Papers that are included in the search criteria are published in the 2018-2022 range from the Scopus database which is in English with the subject area of environmental science. The keywords used are circular economy, plastic waste and the state. The combination of this search resulted in 145 papers with a filter process 2 times, the first filter process by reading the title and abstract of the paper resulted in 67 papers, the second filter by reading the contents and conclusions resulted in 36 papers and the last filter by adjusting the parameters relevant to the scope and The research objective was to produce 21 final papers (Table 1). Papers related to the condition of plastic waste management in Indonesia apart from all the selected papers.

Table 1. Keywords for Paper Search

Year	Keyword	Scopus	Filter 1	Filter 2	Final
2018-2022	“Circular Economy” AND “Plastic Waste” AND “Country”	145	67	36	21

3. Result

This section analyzes descriptively from 21 selected papers related to the year of publication, research methodology and geographical location which are presented in the form of Table 2. From the table it can be seen that since 2018 the issue of the circular economy has been in high demand and has been studied, especially in the last two years. Based on research methodology, analysis is the most widely used method followed by article review. The analysis that is often done is the Material Flow Analysis (MFA) model. MFA is a tool that is widely used in the environmental field for decision making. MFA results can contribute to saving natural resources and minimizing environmental impacts, as well as pursuing sustainable development goals[6][7]. Then from the geographical side, it is divided into 5 continents and 10 countries are in Asia. This shows that countries in Asia are currently running quite

fast towards a circular economy. The countries involved in the review and being discussed in the selected paper are Sub-Saharan Africa[8], European Union[4], South Africa[7], Denmark[6], Qatar[9], Singapore[10], Taiwan[11][12], Brazil[13], India[1], Italy[3], Kenya[14], Malaysia[15], Sweden[16], USA[17], Netherlands[18], South Korea[2][19], China[20] and Australia[21].

Table 2. Compilation of Year, Methodology and Geographical Location of 21 Selected Papers

Year		Research Methodology		Geographic Location	
2018	3	Review	5	Africa	3
2019	0	Analysis	7	Europe	6
2020	7	Survey	3	Asia	10
2021	7	Comparative	2	America	1
2022	4	Descriptive	3	Australia	1

4. Discussion

This section discusses the main factors of this research related to the scope of research, namely the circular economy of plastic waste.

4.1. Best Practice dari Ekonomi Circular

The process towards a circular economy has been proclaimed by several countries, there are countries that are successful in implementation and there are also countries that have difficulties. In this research, it was found that there are several reasons that hinder the low progress towards this. The obstacles faced by many countries can be briefly seen in Figure 1.

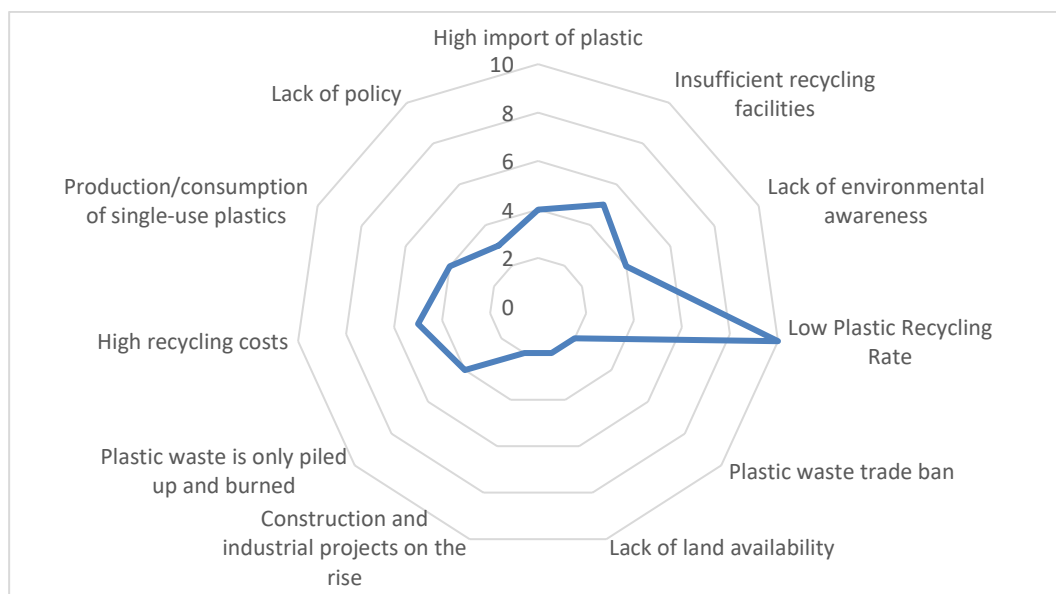


Figure 1. Circular Economy Barriers in various countries

In Figure 1 we can see that the main problem with the low level of the circular economy of plastic waste in several countries is the low recycling rate of plastic waste. The trigger for this occurrence is due to the lack of recycling facilities and the high costs that must be incurred for this process. This is the case in many developing countries.

A comparison of the recycling rates of plastic waste between countries can be seen in Figure 2. This figure shows which countries have high and low levels of plastic waste recycling. South Korea (60%)[19], the Netherlands (57%)[18] and Taiwan (51%)[11] are examples of best practice countries that have succeeded in recycling their plastic waste. On the other hand, Singapore (6%)[10], USA[17],

Australia[21] and Qatar[9] (9%) respectively are countries with low plastic waste recycling rates. The reasons for the success of the circular plastic waste economy program in the three countries can be seen in Table 3.

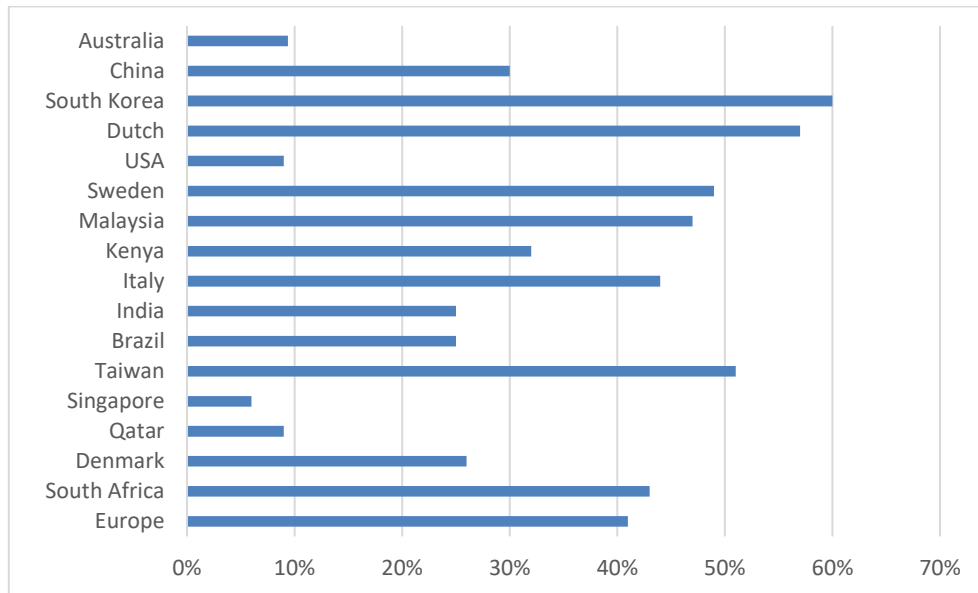


Figure 2. Recycling Rate

4.2. Plastic Waste Management in Indonesia

Indonesia will produce 28.60 million tons of waste in 2021. This number decreased by 12.80% compared to the previous year which was 32.82 million tons. As much as 15 percent of which is plastic waste[5]. A global study, Indonesia is the second largest country in the world after China which contributes to the generation of plastic waste into the ocean[22].

The amount of plastic waste generation in Indonesia tends to increase from year to year along with the increase in population. Types of plastic found in urban waste include Light Density Poly Ethylene (LDPE), PP (Poly Propylene), High Density Poly Ethylene (HDPE), Poly Vinyl Chloride (PVC), Polyethylene Terephthalate (PET), Styrofoam, etc. Most of them are PP and HDPE. A lot of plastic bag waste does not reach the landfill and only a little is recycled, so a lot of plastic bag waste ends up in waterways, rivers, and finally into the sea. A study conducted by the Directorate General of Pollution Control and Environmental Damage (PPKL) of the Ministry of Environment and Forestry shows that the most common type of waste found in marine waters in Indonesia is plastic (42%)[23].

In response, the Government of Indonesia has stated a target of reducing plastic waste by up to 70% by 2025. As a strategic guide for ministries/institutions and a reference for the community and business actors to accelerate the handling of plastic waste until 2025, the National Action Plan (RAN) for Marine Plastic Waste for 2018-2025 is established. The RAN for marine plastic waste consists of five main strategies as follows: (1) national movement to increase awareness of all stakeholders, (2) management of plastic waste from (land) sources, (3) management of plastic waste in coastal and marine areas, (4) mechanisms to increase institutional strength, funding, and law enforcement, and (5) research and development.

The government is also in the 2020-2024 RPJMN targeting a reduction in the percentage of waste thrown into the sea in 2024 by 60% of the amount of plastic waste wasted in 2019. Several local governments have also banned the use of single-use plastics (straws and plastic bags). in shopping centers.

In formal regulation, Indonesia has issued quite some policies related to waste management in general, ranging from laws, government regulations, presidential regulations, ministerial regulations, to regional head regulations, but the problem of solid waste is still not resolved. This may be due to the

minimal budget, inadequate facilities and especially the lack of public awareness and the low responsibility and commitment of producers to recycle.

4.3. *The Potential for Adoption of the Circular Economy*

The circular economy can contribute to three important aspects [61]. First, a circular economy can increase productivity and increase economic growth. Second, it can improve the quality and quantity of labor. Third, a circular economy can help save lives by reducing environmental impacts such as air and water pollution and climate change. The three countries with the highest recycling rates (Figure 1) can be good examples in this study for adoption.

South Korea is the best example that can be adopted by Indonesia in moving toward a Circular Economy. South Korea divides the circulation system into four stages, namely, production, consumption, disposal and recycling, with 3 main objectives: reducing waste generation, increasing the recycling rate and reducing the final disposal rate (this is following the 3R principle).

Table 3. The Circular Economy of Plastic Waste in South Korea, Netherland and Taiwan

Country	Method of CE	Policy
South Korea[2][19]	Recycling from the household separated from the source Implementing a pay-as-you-throw system Reduce production and consumption of single-use plastic packaging Waste mart Implementing Extended Producer Responsibility (EPR) methods for recycling	Safe disposal - waste policy in Korea from 1980 (waste Control Act) Recycling 1992-2003 RCA (Resource Circulation Act) 2016 RCMP (Resource Circulation Master Plan) 2018-2027 PWCP (Plastic Waste Control Plan) 2018-2039 Target - Reduction PW 50%, Recyrcycling PW 70%
Netherland[18]	Have a strong plastic waste management system Recycle plastic waste 57% Energy recovery 42%	Become 100% circular by 2050 and its Circular Economy Action Plan focuses on plastics 23 policies towards a circular plastic economy
Taiwan[11][12]	Recycling plastic containers, Disposable plastic restrictions Green design Source reduction Recycling enhancements Circulation and regeneration	Develop a roadmap in 1997 to reduce the generation of plastic waste (Phase I 1997-2018) to a circular economy (Phase II 2019 - present) Targeting Single-Use Plastic Packaging (recycled contents) 2025: 25%

The database of 21 reviewed papers can be accessed at the following link: <https://s.id/1cIVg>

Some of the methods applied there include recycling from the household separated from the source, implementing a pay-as-you-throw system, reducing the production and consumption of single-use plastic packaging, most of the plastic waste is processed by energy recovery (waste to energy), waste mart (where to exchange recycled plastic for goods/cash/points) and apply EPR methods for recycling. With the implementation of these methods, South Korea can increase the recycling rate of plastic waste by up to 60%, the highest of several countries reviewed in this paper (Figure 2).

The Netherlands is also a concern. They have a strong and adequate waste handling infrastructure so that they can recycle large amounts of waste and apply waste to energy. The reason is that the Dutch Economy Action Plan focuses on handling plastic waste, establishes an institution that ensures producers are responsible for recycling their products (similar to EPR) and is complemented by the policies issued. Likewise, Taiwan has prepared a roadmap for handling plastic waste since 1997 in order to transition to a circular economy. They applied various successful methods and the process was divided into 2 phases as shown in Table 3.

EPR regulation of South Korea, producers must annually collect and recycle the specified amount according to the mandatory recycling rate notified by the Government, those who fail to meet their recycling obligations must pay a fine of more than the recycling fee. The recycling contribution is calculated by multiplying the market in the volume of each product (including imports) by the mandatory recycling target rate per product and the unit cost. After the EPR policy was launched in

2003, increased recycling rate by 32.3%, compared to the period before the EPR system was implemented. Also, it is estimated that 2,264.3 billion won (2.05 billion USD) of economic benefits and 4,260 new jobs have been created in the 5 years[24]. The benefits of EPR to the environment are equally great. With the enforcement of EPR (2001-2008) total energy saving approximately 2.6 trillion won and reduction 15 million tons of CO₂[25]. This EPR recycling scheme has succeeded in increasing the recycling rate of plastic in South Korea and also in line with the circular economy objectives as discussed at the beginning of this sub-chapter. This method has also applied in India, Netherlands, Sweden, Italy and many other European countries.

The policy regarding EPR in Indonesia has actually been mandated in Law Number 18 of 2008 concerning Waste Management, especially in Article 1 which reads: "Producers are obliged to manage the packaging and/or goods they produce that cannot or are difficult to decompose by natural processes". Although this article does not textually mention EPR, the presence of this law is the legal basis for demanding the roles and responsibilities of producers in efforts to reduce and manage waste[26].

However, even though it has been mandated in law, it was revealed through Government Regulation Number 81 of 2012[27] and Ministry of Environment and Forestry Regulation Number 75 of 2019[28] that the implementation of EPR has not become mandatory. EPR is still implemented voluntarily. According to producers, the application of EPR will increase the cost of producing a product, plus the use of biodegradable products, which are not cheap and therefore economically inefficient. Therefore, it is necessary for the government to be serious in implementing the EPR method, for example by establishing institutional and technical regulations related to this matter, stronger law enforcement by providing incentives to industry players who have implemented and providing punishment for industries that do not implement EPR. Likewise with other circular economy models that carry the concept of reduce, reuse and recycle. The regulations already exist in Indonesia but their implementation has not been going well.

5. Conclusion

Plastic waste production continues to grow along with industrial growth and population growth. Plastic waste that is difficult to decompose causes damage to the environment, especially the sea. The circular economy agenda changes the community's paradigm of waste management including plastic. The transition to circularity has been implemented in many countries in the world by issuing various policies and methods. Low recycling rates are a major obstacle in many countries. Due to the lack of facilities and high costs for it. South Korea is one of the leading countries in the process towards a circular economy. With a well-thought-out strategic plan and a systematic policy, this country will continue to achieve the targets they want, one of which is a high recycling rate with their EPR system. In addition, several countries can be good examples to be adopted in Indonesia, such as the Netherlands and Taiwan. Indonesia has formally issued quite a several policies in the field of waste but it has not been implemented properly.

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