Developing New Indonesia Circular Economy Indicators: A Lesson Learnt from European Union

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***Abstract*—Circular Economy (CE) right now has been a point of interest among countries in the world as a commitment of the Paris Agreement to solve global environmental problems, which are simultaneously beneficial to economics. However, presently there is no single indicator available that easily be used as a CE standard due to various stresses among the countries. There are different approaches among countries in developing CE indicators, although they are still within the scope of the environmental and economic aspects. CE indicators could be developed based on region covering several countries, government/country level, and company level. Those indicators refer to the region and government policy and market or users of the product and a society where its public area would receive waste that the company might produce. This review will discuss only European Union and Poland, representing regions and countries. A region like the European Union (EU) considers ten indicators for CE, consisting of 21 sub-indicators. These indicators include self-sufficiency in raw materials, procurement for the green public, waste generation, food waste, recycling rate, recovery of specific waste streams, recycled materials to raw materials demand contribution, raw material trade-in, investment, jobs, and gross value-added, patents of secondary and recycling raw materials. While Poland, as a member of the EU, developed 25 CE indicators based on the seven dimensions of the economic point of view, such as economic prosperity, zero waste, innovative, renewable energy-based economy, low carbon, smart economy, and spatially effective economy. Implementing a Comparative Analysis Method that compares one indicator to another, the results show that 6 of 10 indicators belonging to the EU overlap with four indicators of 25 belonging to Poland. Covering all indicators of both regions and countries, thus it would become 29 selected indicators that might be useful for developing Indonesia CE-Indicators, which are presently unavailable yet.**

***Keywords*—Circular Economy, Country, Environment, Indicator, Region.**

I. INTRODUCTION

THE concept of Circular Economy (CE) has become a point of interest among countries today as a commitment from the Paris Agreement to solve global environmental problems while providing economic benefits. The Paris Agreement aims to reduce global warming to below 2 Celcius, compared to pre-industrial levels, through binding international legal agreements supporting the threat of climate change [1]. The adoption of CE principles and strategies is believed to have the potential to contribute to achieving climate targets, but there is no firm evidence of this. The concept of CE itself still has many different definitions, and until now, there has been no mutually agreed upon CE concept [2–4].

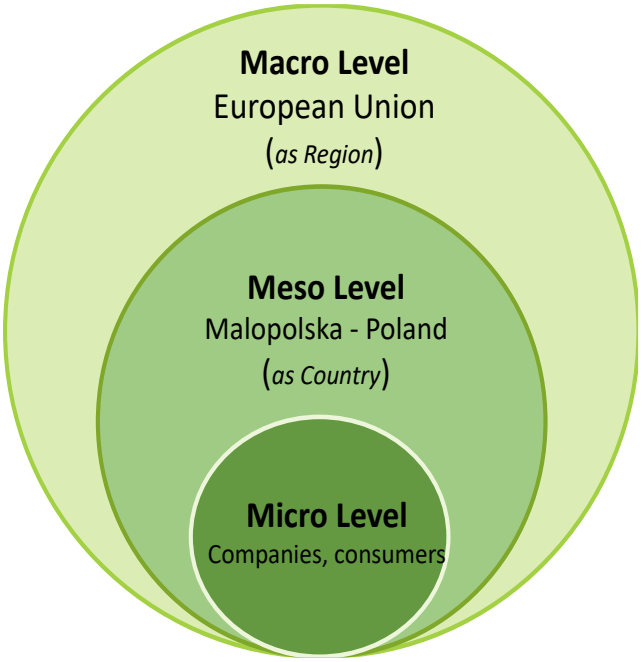

Figure 1. The system-level approach to EU CE in this study.

The CE concept then developed into a more practical approach starting from the macro to micro levels. There are differences in approaches between countries in developing CE indicators, although they are all within the same scope: environmental and economic. The Chinese central government initially proposed and officially accepted the CE concept as a new development strategy to harmonize rapid economic growth with limited raw materials and energy. China also has a closed-loop approach to waste recycling and internal industrial waste management [5]. Meanwhile, the CE concept was initiated in Germany through environmental policies related to using raw materials and natural resources for a sustainable economy [6].

Despite these different approaches, there is a need to measure progress in CE adoption. The existence of indicators is expected to help measure the implementation of CE. However, this assessment indicator is still being debated in various countries, so there is no single available indicator that is easy to use as a global CE standard. CE indicators can be developed at the government level (macro level), the regional level that includes several countries (meso level), and the enterprise level (micro level), where some indicators refer to

Table 1.
CE Indicators for European Union to Measure CE Implementation

	Indicator	Sub-indicator	No
1	Raw materials self-sufficiency	-	
2	Procurement of green public	-	
3	Waste generation	Generation of municipal waste per capita	1
		Generation of waste per GDP	2
		Generation of waste per DMC	3
4	Food loss	-	
5	Recycling rates	The municipal waste recycling rate	4
		Recycling rate of all waste	5
6	Specific waste streams recycling	The overall packaging recycling rate	6
		Recycling rate of packaging waste by type	7
		The wooden packaging recycling rate	8
		The e-waste recycling rate	9
		The biowaste recycling rate	10
		The C&D waste recycling rate	11
7	Contribution of recycled materials to raw materials demand	End-of-life recycling input rates	12
		Circular material use rate	13
8	Trade in recyclable raw materials	Imports from non-EU countries	14
		Exports from non-EU countries	15
		Imports from EU countries	16
		Exports from EU countries	17
9	Investments, employment, and share of GDP	Gross investment in tangible goods	18
		Number of persons employed	19
		Value added at factor cost	20
10	The intellectual property of recycling and secondary raw materials	Registered patents of recycling and secondary raw materials	21

the region and government policies as well as market or product users and society in the area who will receive the waste that the company may generate. [7]
In this review, we are limited to discussing the European Union (EU) CE indicator, which represents the region (macro-scale), and the EU region CE indicator which has been implemented in Southern Poland, which represents the country (meso-scale).

II. METHOD

The methodological approach of this research is a comparative analysis that compares one indicator with other indicators. Starting with identifying CE indicators considered more macro as a standard of comparison. In this regard, the CE indicator for the EU region (Table 2) is more macro than the CE indicator of the EU (Table 1). This can be seen from the dimensions of the CE indicator used in the EU region, which has a broader scope both from the economic and environmental aspects as well as the innovation aspect.

Furthermore, an in-depth analysis is carried out to find more detailed definitions and calculation methods for each CE indicator and whether sub-indicators support it. A comparative study between 2 CE indicators makes it possible to identify which ones overlap each other. A final CE indicator can be obtained that can describe all aspects and be used to develop new indicators.

A. CE Indicators for the EU

The "CE monitoring framework" has been initiated by the European Commission to measure the progress of CE implementation in the EU and member states. It consists of ten CE indicators and 21 sub-indicators divided into four focus areas: secondary raw materials, production consumption, waste management, and innovations (Table 1). However, if we take a closer look, the 8 CE indicator focuses on materials to preserve materials through recycling and recycling.

This CE indicator is divided into two classifications: direct and indirect CE indicators. The direct CE indicators focus on waste production and material measurement, while the indirect CE indicator focuses on materials and their aspects. The CE indicator is divided into two classifications: direct and indirect CE indicators. The direct CE indicators focus on waste production and material measurement, while the indirect CE indicator focuses on materials and their aspects. However, there are some limitations to this EU monitoring framework, such as: in resource flows, the role of the consumer has not been defined, relevant indicators in the CE business model and the eco-design are missing, macro-scale data on products are unavailable, and a correlation between micro-scale and macro-scale indicators has not been seen [8].

B. CE Indicators for the EU Region (Case Study:Southern Poland)

The regional CE indicators are proposed considering that the CE concept in Europe has a diverse scope, including broader issues such as new business models, new consumption patterns, smart solutions, innovation, and green design, which are less relevant at the regional level [9]. There are 25 CE indicators categorized into seven economic dimensions: prosperity economy, zero waste, innovative, low carbon, smart economy, spatially effective, efficient, and renewable energy-based economy (Table 2Table 2).

Table 2.
CE Indicators for the EU Region to Measure the CE Development

	Economic Dimension	Indicators	No
1	Economic prosperity	GDP	1
		Average life expectancy at birth for men	2
		Registered unemployment rate	3
		At-risk-of-poverty rate	4
2	Zero-waste	Municipal waste collected selectively	5
		Municipal waste collected per one inhabitant	6
		Industrial and municipal wastewater purified in wastewater	7
		Fixed assets expenditure serving environmental protection and water management related waste	8
3	Innovation	R&D expenditures	9
		Average share of innovative enterprises in the total number of enterprises	10
		Number of people who participating in learning	11
		Patent applications for 1 million inhabitants	12
4	Energy-efficient and renewable energy-based economy	Share of renewable energy sources in total production of electricity	13
		Fixed assets expenditure serving environmental protection and water management related electricity	14
		Electricity consumption	15
5	Low carbon	CO2 emission from plants especially noxious to air purity	16
		Emission of particulates	17
		Number of passenger cars	18
		Pollutants retained or neutralized in pollutant reduction systems in total pollutants generated from plants especially noxious to air purity	19
		Fixed assets expenditure serving environmental protection and water management related to climate	20
6	Smart economy	Personal computer with broadband connection to Internet	21
		Enterprises with access to the Internet via a broadband connection	22

C. Scope of CE Indicators

This review has a limited scope on the EU CE indicator, which represents the region (macro-scale), and the EU region CE indicator that has been implemented in Southern Poland, which represents as a country (meso-scale) adopted [7] the system-level approach to the circular economy as shown in Figure 1.

III. RESULT AND DISCUSSION

A. Comparison of CE Indicators for EU Regional and EU

Four indicators overlap in comparing CE indicators for the EU and EU regions by considering the definition and calculation method (Table 3). The EU regional "registered unemployment rate" indicator has the same meaning as employment in the EU "Investments, employment, and share of GDP indicator. So it is proposed to be an indicator with a new name, namely "Jobs", which means the number of people working in the CE area.

Furthermore, the EU regional indicator “municipal waste collected selectively about the total amount of municipal waste collected” has the same meaning as the EU's “recycling rate”, “food loss” and “specific waste stream recycling”. So it is proposed to be an indicator with a new name, namely "waste recycling rate", showing waste from end customers, including packaging material waste, food waste, and plastic packaging as CE resources. The waste recycling rate indicates the quality of the entire waste management system.

The EU regional indicator "municipal waste collected per one inhabitant" has the same meaning as the EU's "waste generation". So it is more appropriate if it becomes an indicator with a new name: "waste generation", meaning the amount of municipal waste collected on behalf of individuals and cities through the waste management system. Generally comes from household waste, although similar waste can come from trade or offices. Excluding waste from agriculture and industry. It can be calculated from the amount of municipal waste generated divided by the total population.

The EU regional indicator "patent application for 1 million inhabitants" has a broader meaning than the EU "registered patent related to recycling and secondary raw materials". Hence, the new indicator uses the term "patent application for 1 million inhabitants," which means that patent registration covers all relevant documents with different findings to prevent repetition. Calculated from the number of patent applications registered for 1 million residents. Thus, the remaining number of CE indicators can be calculated as follows:

A. Number of selected CE indicators = number of CE indicators for the EU region + number of CE indicators for the EU - number of overlapping CE indicators

B. Number of selected CE indicators = 25 +10 – 6

C. Number of selected CE indicators = 29

The 29 selected CE indicators (Figure 2), which represent the EU and EU regions, cover economic and environmental aspects so that they can be considered new CE indicators in Indonesia. However, it should be considered that compared to China, which makes CE the primary strategy in its national development, the European Union is still developing an integrated CE indicator. This is because, at the regional level that initiates each CE indicator, it is considered difficult to measure the implementation of CE at a more macro level by adopting the experience of case studies from the China region. At the same time, China and the EU have different problems. China's issues are generally environmental

Table 3.
Overlapping CE Indicators for EU and EU Regional and Recommendations for New Indicators for CE Indicator Development

Economic Dimensions for EU	CE Indicators for EU Regional	CE Indicators for EU	New Name Indicator	Description
Economic prosperity	1 Registered unemployment rate	1 Investments, employment and share to GDP	1 Jobs	"Jobs" means the number of people working in the CE areas/department/unit. For example, in a company, the number of employees includes the employer, Partners who regularly work in the CE unit, and People who work outside the CE unit are owned and paid by the company (sales representatives, delivery personnel, maintenance team). Excludes: labor supplied to the unit by another company (third party)
Zero-waste	2 Municipal waste collected selectively in relation to the total amount of municipal waste collected	2 Recycling rates 3 Food loss 4 Specific waste streams recycling	2 Waste Recycling rates	The waste recycling rate shows the waste from end customers, including packaging material waste, food waste, and plastic packaging as CE resources. The waste recycling rate indicates the quality of the entire waste management system.
	3 Municipal waste collected per one inhabitant	5 Waste generation	3 Waste generation	The amount of municipal waste collected on behalf of individuals and cities through the waste management system. Generally comes from household waste, although similar waste can come from trade or offices. Excluding waste from agriculture and industry. It can be calculated from the amount of municipal waste generated divided by the total population.
Innovation	4 Patent applications for 1 million inhabitants	6 Registered patents related to recycling and secondary raw materials	4 Patent applications for 1 million inhabitants	Registered patents include all documents relevant to different inventions to avoid repetition. Calculated from the number of patent applications registered for 1 million residents.
Number of indicator	4	6	4	

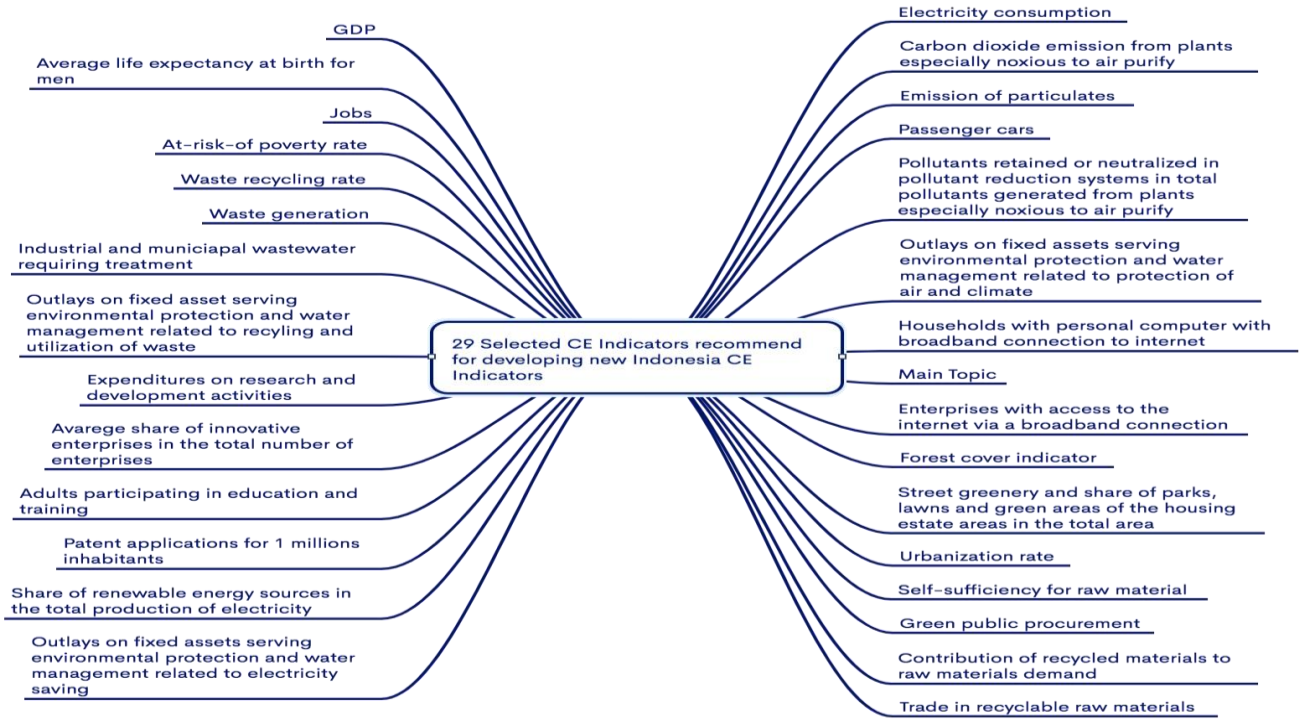

Figure 2. Selected CE indicators recommend the development of New Indonesia CE indicators.

problems and pollution, while the European Union is on the use of raw materials and resource efficiency, waste management, new business process, new jobs, environmental innovation, and social innovation [5], [9–12]. Therefore, a country's indicator system must consider the country-specific CE context if it will be proposed as a CE indicator in Indonesia.

IV. CONCLUSION

It should be considered in developing new CE indicators in Indonesia by examining important CE issues in Indonesia, mainly related to economic, environmental, and social aspects. As this analysis shows, there are 29 CE indicators

selected from 35 CE indicators belonging to the EU and EU regions. There are 6 out of 10 EU indicators that overlap with those in the EU region. The overlapping indicators were then given a new name that more accurately describes the two indicators. The 29 selected CE indicators can be proposed as new Indonesian CE indicators because of the similarity of global issues, namely environmental issues, so CE indicators adopted in the EU can also be adopted in Indonesia.

Developing new CE indicators in Indonesia should consider important CE issues in Indonesia, mainly related to economic, environmental, & social aspects. CE indicators must adapt to each region's strategies and action plans. It is necessary to consider the SDGs targets in Indonesia and the specificity of CE in Indonesia.

ACKNOWLEDGEMENT

This research was funded by The Directorate of Research, Universitas Gadjah Mada, Yogyakarta, Indonesia, through the Indonesian Collaborative Research Program (RKI) 2022, stated in the Notification Letter Number: 1561/UN1/DITLIT/Dit-Lit/PT.01.03/2022.

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