TOWARDS CIRCULAR ECONOMY: ANALYSIS OF INDICATORS IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Abstract

Purpose – Circular economy is quite new approach in European Union in dealing with main global challenges. Circular economy evaluation system should show results that could be used by decision makers: it could be used at national, local or enterprise level. This paper analyzes how circular economy evaluation systems reflect basic circular economy principals and sustainable development components.

Design/methodology/approach – analysis based on assessment whether circular economy evaluation systems do or do not include indicators of basic circular economy principles and sustainable development components.

Findings – at micro and meso levels circular economy evaluation systems do not include social component indicators of sustainable development approach, even there are some systems that even do not include all basic circular economy principles. At macro level there are two evaluation systems that covers both circular economy principles and sustainable development component, but statistical data availability should be analyzed in further studies.

Research limitations/implications – In European Union circular economy evaluation systems and their methodology are still developing. In Eastern Asia these evaluation systems are broadly implemented but there is a risk, that not all circular economy evaluations systems are analyzed, because of language barrier: not all Asian evaluation systems are translated into English. The analysis does not go into deep details of circular economy evaluation systems methodology.

Practical implications – the findings of the research can be used in further studies and also   applied by national authorities to determine actions that could be funded in order to develop more complex circular economy evaluation system that could give more holistic approach.

Originality/Value – Analysis is important and valuable as circular economy evaluation systems are not analyzed by researches in a context of sustainable development. This approach to evaluation systems could lead to new and more complex evaluations systems, that could give information for decisions makers on further strategy formation.

Keywords: circular economy, sustainable development, circular economy evaluation systems.

Research type (choose one): research paper

Introduction

Sustainable development is not new concept, it was developed over few decades and its implementation is a complex task requiring long term and continuous governmental efforts. Circular economy (CE) is a kind of new economy form and economic-environmental development model. CE model is approach of sustainable manufacturing that focuses on a broader, innovation-based methodology for products over multiple life-cycles (Jawahir, Bradley, 2016). As the concrete form which reflects sustainable development strategy, circular economy is becoming main development strategy in more and more regions and countries. It is important to combine these two approaches developing evaluation systems in order to get full view of performance and make right decisions, so setting right and complex indicators to evaluate circular economy is first and the most important step in creating effective evaluation system.

Evolution of circular economy

The concept of a circular economy, introduced by the late Pearce and Turner in 1989, addresses the interlinkages of four economic functions of the environment:
(1) amenity values - the pleasures from natural beauty of nature and existence value of particular species. These pleasures environment provides directly without interference from economy;
(2) a resource base for the economy – as an input, economy needs resources, both renewable and non-renewable, that provides environment. Renewable resources usually are biological and can be harvested for economic purposes with no or limited impact, as long as the harvest does not exceed the annual yield.
(3) a waste bin for residual flows – for the residuals (waterborne, airborne or solid emissions) after economic activity the environment functions as a waste bin and once the assimilative capacity, that environment can receive, is exceeded, environmental damage begins to surface;
(4) a lifesupport system - for humans and non-humans, the environment functions as a life-support system, that acknowledges the inherent biological character of the environment and that the life-support function can be influenced as a result of economic activities (Andersen, 2007).

From the perspective of environmental economics, the circular economy is based on a material balance principle (Kneese et al. 1970), which implies that all material flows in order to guide their management need to be accounted in economic values, not the physical flows. In industrial ecology, the circular economy is beneficial to society and to the economy as a whole. Benefits can be obtained, not only by minimizing use of the environment as a waste bin for residuals but also more important by minimizing the use of virgin materials for economic activity (Andersen, 2007)

Concepts such as Cradle-to-Cradle or Biomimicry (1997), which were inspired by nature as well, also had an influence on the development of the Circular Economy concept (Sherwin 2013). It is also a mixture of several other schools of thoughts, such as Performance Economy (1976), Industrial Ecology (1989) and Blue Economy (2010) (Ostojic, 2016).

Basic circular economy principles have been formulated based on waste hierarchy and 3R principles: reduce, reuse and recovery. The first principle – reduce, means

achieving the objectives set for production and consumption by using minimal raw materials and energy and by cutting pollution at the very outset of economic activity. The second principle – reuse, refers to a reuse of a product at other economic activities or facilities after its initial consumption. Recovery means recycling and use of a product many times in its primary state rather than one-off use (Zhijun, Nailing, 2007). These three principles lead economy to resources circularity and minimization of extraction of raw materials. Evaluating circular economy just as 3R principles may lead to economic and social ineffective actions proposed by decision makers. CE evaluation system should be more complex and integrating those aspects of sustainability that are missing in basic circular economy principles.

Circular economy and Sustainable development

Basically, circular economy model is model of sustainable production and consumption, and it is fundamentally different from the linear economy model. The linear economy is based on linear process: extract – produce - consume – dispose, which does not ensure future generations the same level of welfare as now. In linear economy model there is little or no attention to the pollution generated at each step (Figure 1), and some limitations appear, such as:

- lost value of materials and products;
- scarcity of resources, volatile prices;
- waste generated, environmental degradation & climate change.

Circular economy approach is natural consequence of linear production limitation of limited natural resources, high pollution and energy consumption rates. Wastes generated in linear economy model through extraction and production of the goods and the post-consumption products come around to haunt us as pollution as they eventually end up either in a landfill or are dispersed in ways that contaminate our environment.
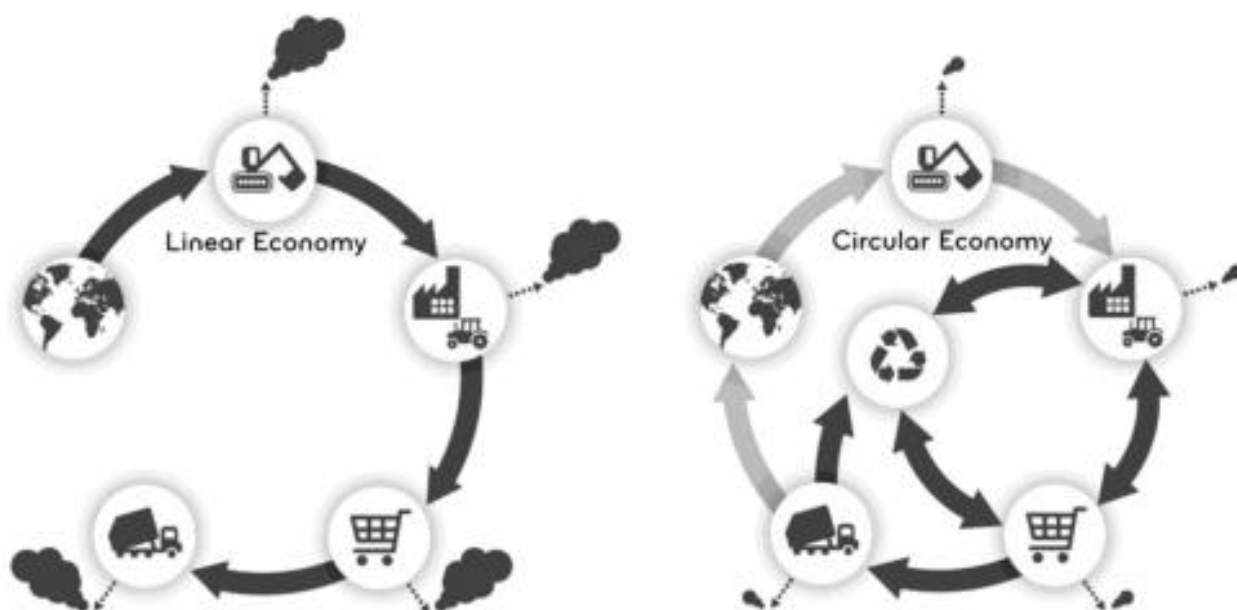
Source: Sauvé et al, 2016

**Figure 1. Contrasting the linear and circular economy concepts**

Circular economy is the outcome of over a decade's efforts to practice sustainable development by the international communities, and is the detailed approach towards sustainable development (Moriguchi, 2007). Considering circular economy only as an approach to more appropriate waste management is very limited and may lead CE to fail. Just seeing circular economy only in reduce, reuse or recovery options and not in the view of sustainability, may either be not appropriate (Ghisellini et al, 2016).

Sustainable development, defined by the UN's World Commission, is a trajectory where future generations are secured the same level of welfare as present living generations (Andersen, 2007) and circular economy is helping to fulfill this goal.

Successful evaluation of CE leads to successful and sustainable development of a circular economy. This goal requires to set key indicators, that would meet both circular economy and sustainable development approaches.

Analysis of circular economy evaluation systems

Analysis of research papers showed, that circular economy can be implemented at three different levels (see Figure 2). Different implementation levels of the CE and different characteristics of enterprises, industries or regions require different assessment indicators. All evaluation systems can be divided into three groups (see Figure 2) with different evaluation systems. The first step of good evaluation systems is to set appropriate indicators at each implementation level.
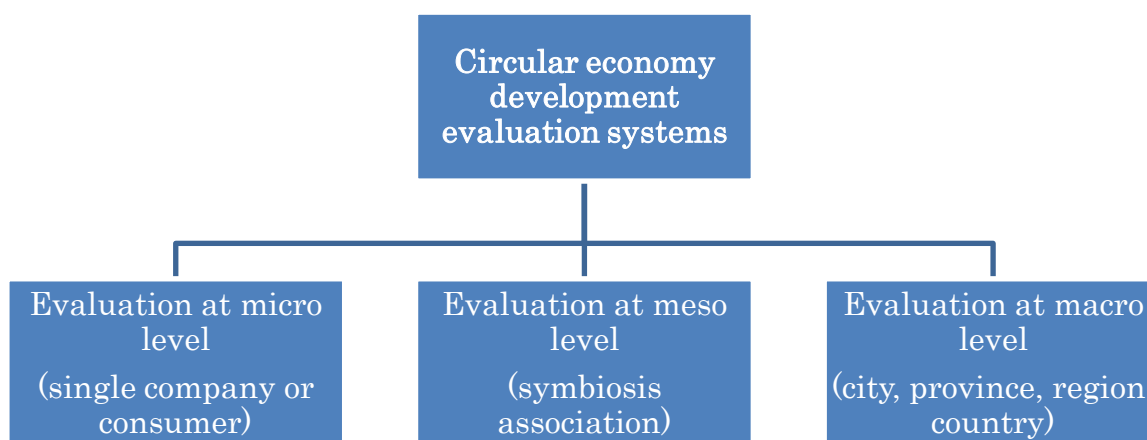
Figure 2. Classification of Circular economy development evaluation systems

CE evaluation at micro level

Micro level means implementing circular economy principles to single company, so evaluating circular economy at this level, each enterprise needs to set specific indicators according to companies characteristics, condition, and existing problems. Thus, setting very unified and only one standard of indicators may fail to capture the full development of the circular economy in different enterprise (Su et al., 2013). The adoption of a circular economy principles entail that a company carries out different strategies to improve the circularity of its production system. Production companies

have to cooperate with other companies over the supply chain for the achievement of a more effective circular pattern (Wrinkler, 2011).

Analysis of research papers showed, that circular economy evaluation at micro level is based on cleaner production, green consumption what is not full CE approach. These evaluation systems contain indicators that mostly are based on 3R principles, but not CE in general (see Table 1).

CE evaluation at meso level

China is one of the biggest producer in the world and have production plants, industry parks and industry networks. China is the second-largest energy producer in the world and also the second largest energy consumer. Country's energy consumption per unit GDP is two times greater than the world average. The high-energy consumption in process industries gives a lot of severe environmental problems. Production plants, industry parks and industry networks is mostly China's production specifics, these production derivatives are evaluated at meso level. These derivatives usually are equipped deficiency and they lag in technology (Li et al, 2010).

Applying the concept of industrial symbiosis, have production plants, industry parks and industry networks utilize common infrastructure and services. This enables these derivatives to cooperatively manage resource flows, trade industrial by products which decrease environmental problems and reduce both firms' and the nation's dependency on resources. Reduction of production cost raises industrial productivity and competitiveness (Heshmati, 2015). By applying circular economy and sustainable development concepts, measuring indicators will help to control these parks and plants performance and to take appropriate decisions.

CE evaluation at macro level

At macro level sustainability and circular economy indicators are necessary for evaluating, monitoring, and improving upon various policies and programs. Policy makers have to have information so they could select specific indicators to fully cover the strategic goal of circular economy development and sustainability. Circular economy evaluation system creation is most popular and have most challenges. Table 1 shows analyzed evaluation systems and just few have all aspects of CE and sustainable development, and most of them concentrates on pollution reduction and other environmental issues.

Table 1. Circular economy evaluation systems at different levels

Circular economy evaluation system	Author	Categories	Individual indicators	Circular economy principles			Sustainable development components		
				Reduce	Recycle	Reuse	Economic	Environmental	Social
Circular economy evaluation systems at micro level									
Indicators for iron and steel enterprise	Chen et al., 2009	4	12	+	+	+	-	-	-
Factor analysis based on ESCC and CE-targeted performance indicators	Zhu Q. et al., 2010	7	41	+	+	+	+	+	-
Quantitative Evaluation of Circular Economy Based on Waste Input-Output Analysis	Li S., 2012	-	14	+	-	-	+	+	-
Circular economy evaluation systems at meso level									
Material flow analysis (MFA) to evaluate Circular economy	Geng Y. et al., 2012	4	12	+	+	+	-	+	-
National Development and Reform Commission's (NDRC's) CE indicator system	Su B. W. et al., 2013	4	13	+	+	+	-	-	-
Ministry of Environmental Protection (MEP's) CE indicator system	Su B. W. et al., 2013	4	21	+	+	-	+	+	-

Circular economy evaluation system	Author	Categories	Individual indicators	Circular economy principles			Sustainable development components		
				Reduce	Recycle	Reuse	Economic	Environmental	Social
Circular economy evaluation systems at macro level									
Regional Circular Economy Development index	Guo-gang J., 2011	4	16	+	+	-	+	+	+
Super-efficiency DEA model	Wu H.et al., 2014	3	31	+	+	+	+	+	+
Evaluation of Regional Circular Economy Based on Matter Element Analysis	Chun-ron J. and Jun Z., 2011	3	10	+	+	+	-	-	-
Integrative Evaluation on the development of Circular Economy	Qing Y.et al., 2011	5	26	+	+	+	+	+	+
Material flow analysis (MFA) to evaluate Circular economy	Geng Y. et al., 2012	4	22	+	+	+	-	-	-
An indicator framework for the evaluation of circular economy development in cities (The Development Research Center of the State Council)	Li H. et al., 2010	3	28	+	-	+	+	+	+
Circular economy indexes system of State Environmental Protection Administration	Li H. et al., 2010	4	8	+	+	+	+	+	-
Multi-objective evaluation system of the economy–environment–ecology for high efficient utilization of resources (The Institute of Process Engineering, Chinese Academy of Sciences)	Li H. et al., 2010	3	12	+	-	+	+	+	-

Conclusions

My review results show that current CE evaluation indicators are being carried out at the micro, meso and macro levels.

At the micro (enterprise) level, indicators are tailored to individual firms or an industry's characteristics and not focuses on both circular economy and sustainable development principles and components. The review shows, that aside from indicators evaluating 3R principles or the environmental aspect, a more systematic evaluation system should be established by adding indicators of economic development and social aspects.

There are no social indicator's in reviewed CE evaluation systems at the meso level. Also it should be paid more attention to economic indicators, because all indicators mostly focus on resource reduction and recycling.

At the macro level, where the research studies are the most abundant, the indicator systems are generally based on 3R principles and just some integrate all sustainable development components. In this level sustainable indicators are essential. For policy-makers it is important to know countries situation so indicators and indices are increasingly accepted as useful tools because they convey information on a country's performance towards their specific goals within the three major divisions of sustainability (social equity, economic welfare, environmental quality).

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