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COULD RRI APPROACH PLAY KEY ROLE IN ESTABLISHMENT OF CIRCULAR ECONOMY?

Boris Kalioujny (a)*, Janna Ermushko (b)

* Corresponding author

(a) Tomsk Polytechnic University, 634050 Lenin Avenue, 30, Tomsk, Russia, borisk@tpu.ru

Abstract

The paper considers a new model of economics - the model of circular economy (CE) that integrates environmental protection and economic efficiency in order to reach goals of sustainable development. The model of circular economy suggests to create virtuous loops into the system of economics and new ways of societal progress and reaching for success that involve radical structural changes in conception, production and consumption of goods and services in the global economy. The present article describes the main problems for integration of circular economy into society. The authors of the paper explore an approach of responsible research and innovation (RRI) to discuss possible solutions convenient for circular economy integration by different actors of society. Responsible research and innovation approach is a new way on how scientists, entrepreneurs, politics and citizens, which exert a strong influence over human development can assemble theirs strengths to reach common objectives for a better future.

Keywords: Circular economy; sustainable development; responsible research and innovation; technology assessment; innovation.

1. Introduction

Due to adoption of “The Rio Declaration on Environment and Development” in 1992 in Rio de Janeiro, Brazil, and need in a new model of economics and behavior integrating sustainable ways of production and consumption, the model of circular economy (CE) was taken into consideration. It began to evolve in 1976 with the works of two scientists, Stahel, and Reday (1981). Their studies were devoted to the problems of life cycle analysis of goods and waste recycling. The CE model is also based on the theory of “industrial ecology” developed in the early 1990’s by scientists of the National Academy of

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Engineering, the USA (Erkman, 2004). There is also the principle of "cradle to cradle" invented in 2002 by Braungart and W. McDonough that influenced the CE-model development (Adoue et al., 2014).

Circular economy is applied with the intention to modify the currently acting linear model of economics (Figures 1 and 2). The Institute of Circular Economy in Paris defines the CE as "a new economic system based on the principle of ecosystems' functioning with the aim to avoid dependence of economic growth on the exhausting natural resources by means of creation of innovative products, services, business models and national policies" (Adoue et al., 2014).

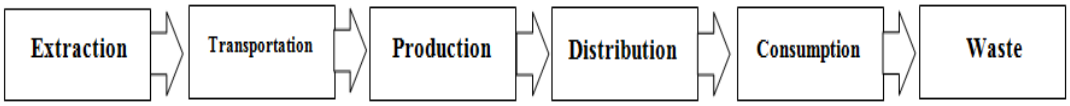

Fig. 1. Outline of acting linear model of economics

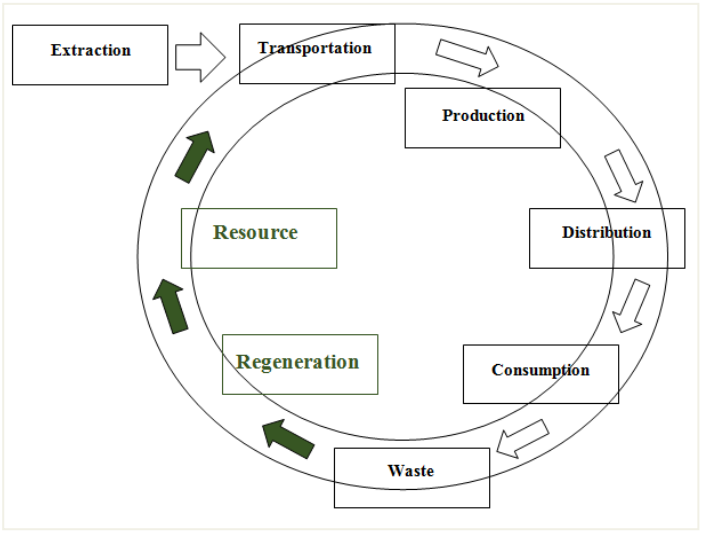

Fig. 2. Outline of circular economy model

Formation of new closed loops in the process opens a prospective for important reduction of a negative impact on the environment, stimulates the economy development and improves well-being of society. Indeed, an increased number of the recycling loops increase the amount of reused materials and saved energy, providejobs creation, enhancement of safety etc. In order to form a maximum number of the recycling loops targeting an accomplished transit to the CE model, it is important to use the waste hierarchy Four-R's Theory (reduce, reuse, rehabilitate and recycle) described in the works of The Product-Life Institute (Fig. 3), at every level of production and consumption. Firstly, the society has to reduce utilization of untapped resources, maximize reuse and rehabilitation, and, finally recycle products (Adoue et al., 2014). By integrating the CE model, it is possible to achieve the goals of principles 3, 7, 8 and 16 described in The Rio Declaration:

- equitably meet developmental and environmental needs of present and future generations;
- preserve, protect and restore the health and integrity of Earth's ecosystem;
- reduce and eliminate all the unsustainable production and consumption models;
- encourage the integration of environmental costs and the use of economic instruments.

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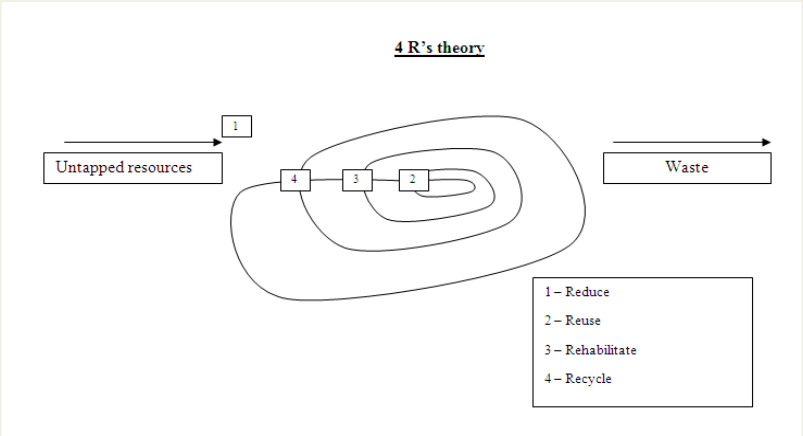

Fig. 3. 4 R's theory

The main aim of this article is analysis of the RRI approach as an instrument to discuss for actors of society different issues to problems of (real) global circular economy (CE) model integration.

2. Materials and methods

This paper considers several integrated efficiency criteria of RRI approach application. Firstly, detailed examination of the main problems that the CE model actually faces was undertaken. Secondly, a large empirical and theoretical review of the literature concerning RRI was made. Finally, analytical work concerning the mechanisms and instruments of the RRI approach realization in Europe was done in order to undertake the analysis of possible integration of the RRI approach in CE model application.

During the 19th century, industry triumphs with the first two industrial revolutions. The industrial action starts with apparition of the coal in Great-Britain in 1780-s, and the textile industry in Belgium - around in 1840-s. The industrial action will then continue its way through France, Germany, Mediterranean basin and Russia. Thanks to machines, productivity increases, the demand raises, profits explode and the capital accumulates. The economy starts to be more complex: joint-stock companies, railway is all around Europe, the banking system is structured in deposit and investment banks and business acquires a new dimension with development of "department stores". Then the colonization in Africa and in Asia will allow Europeans to get a huge amount of raw materials for very low prices for their development creating the capitalist system. In order to maintain such system, it is necessary for economists to ensure stability of the market knowing that a new system brings new crises. Indeed, capitalism causes industrial and financial crises, marked by overproduction, bankruptcies, unemployment and capital flight (Golliau, 2016). The 20th century has just started and the humanity has already passed through a world financial crisis "the subprime mortgage crisis", and passing through a third (Jeremy Rifkin, computer and automation) and a fourth (Industry 4.0, cyber physical systems) industrial revolutions making the capitalist system even more complicated.

The RRI approach has appeared following the need in a representation of "how science, innovation and research can be shaped in accordance with societal values that builds directly on the concepts and methodologies of Technology Assessment (TA)" (Hahn, & Ladikas, 2014). TA emerged in the 1970's and had the purpose to analyse the risks and opportunities of new technologies, regulate and promote them according to social values and ethical norms (Grunwald et al., 2013).

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One of the most commonly used definitions of RRI is provided by von Schomberg (2012): "Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)."

In fact, RRI would be a more complete conception of TA integrating new criteria into a more complex contemporary system. Indeed, the concept of RRI is aimed at addressing "grand challenges", such as climate change, by achieving a joint responsibility among stakeholders regarding desirable products (Weber, & Dewald, 2015). That is why, in 2014, the RRI approach was integrated into the Framework Programme for Research and Technological Development "Horizon 2020" of the European Union (EU) and was regarded as a "key action of the 'Science with and for Society'". According to the programme Horizon 2020, RRI should integrate following pillars (Hahn, & Ladikas, 2014):

- Engagement (citizen engagement and participation of societal actors on research and innovation (R&I));
- Governance (responsible governance of R&I);
- Anticipation (science foresight, anticipatory technology, risk and impact assessments);
- Ethics (ethics of research and innovation);
- Science education (science literacy and scientific education);
- Gender equality (gender equality in R&I, and gender dimension in R&I content);
- Open Access (open access to scientific knowledge, research results and data).

Despite popularity that RRI meets in the world, it faces some problems. Indeed, RRI requires more standards, a better definition and establishment of an impact assessment through national case studies in different industries and countries (Hahn, & Ladikas, 2015). For example, PRISMA project (Piloting RRI in Industry: a roadmap for tranSforMAtive technologies) aims to compare two similar industries in the EU, one where RRI was integrated and another where RRI was not, including nanotechnologies, synthetic biology, internet of things and self-driving or automated. Another project "RRI-Practice" aims to analyse framework for identifying barriers and drivers in the RRI review.

Other problems such as "share responsibility for the effects of future products" or "the focus on products and assumptions on the role that innovation plays for companies" make conception of RRI fragile and require a better definition (Weber, & Dewald, 2015).

3. Results and Discussion

Today many entities are convinced that global circular economy could allow high economic growth and environmental protection and permit transition to sustainable development, generally called "green growth". Actually, despite global infatuation with CE, only 6% of materials that processed by the global economy are recycled contributing to closing the loop. It indicated that the global and the EU-27 economies are distant from the CE (Haas et al., 2015). Moreover, a study of 2010 "Is recycling «part of the solution»?" demonstrated the limits of recycling: economy of 3% growth per year would multiply the demand by 2 every 20 years approximately. Considering very optimist 50% recycling rate, it still would be necessary to extract 75% of raw materials to satisfy the demand (Grosse, 2010). Annual 1% growth

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would multiply the demand by 2 every 70 years. That is why, beyond the limits of 1% growth in demand for materials, recycling provides no significant reduction of resource scarcity. This makes the questions concerning encouragement of companies and households to apply the CE principles remain.

Transition to real circular economy and to sustainable development needs to involve radical changes not only in production and consumption of goods and services but also and mostly in their conception. The modern economy has to provide goods and services, which have to get into the different loops with a maximisation of reutilisation, following rehabilitation and finally recycling. Such model requires a large economy of resources including four main well-known instruments:

- Eco-conception;

At the beginning of the supply chain, when a product and its packaging are designed, the innovative products and production processes include "as little of non-renewable resources as possible in favour of renewable resources, exploiting their turnover and associated with the waste recovery promoting reuse, repair and recycling" (French Environment and Energy management Agency, translated by B.K.).

- Industrial ecology or Industrial symbiosis;

Considering the analysis of material and energy flows, industrial ecology aims a global approach to the industrial systems. A number of companies in a given territory, in order to optimize production costs and reduce the risks, co-operate in a wide trade network. By-products and waste of a company may become a raw material for another one, which may become a supplier for a third company etc. In addition to raw materials, a common organization for the consumption of resources (energy, water, information etc.) and services (security, cleaning etc.) may be arranged (Erkman, 2004).

- Functional economy;

This is the part of the CE accentuating the necessity to sell the use of a product rather than its property. The ultimate goal is to create the highest possible value for use as long as possible, consuming as little as possibleofmaterial resources and energy. The aim is to reach for a better competitiveness and increase corporate earnings (Adoue et al., 2014).

- Green economy;

The economy mainly focused on the social sphere of sustainable development and on the well-being of the society thanks to rational and efficient utilization of natural resources. It is directly linked with the respect for nature, and seeks maintenance of the natural capital balance (air, water, forests, etc.).

For example, today the globalization of the economy requires more and more transportation that provokes approximately 30% of greenhouse gas emissions, 90% of which is causes by road transport (Ministère de l'écologie, du développement durable et de l'énergie, 2014). During the last decade, the number of pollution peaks has increased in all big cities of Europe. This fact explains necessity to take constraining measures such as alternating traffic in Paris in 2015, or a congestion charge in London in 2005.

As for CE model's tools, it would be necessary to produce cars on a minimum of 40 years horizon with mono-material production for rehabilitation and recycling (eco-conception, industrial symbiosis) that consume as least as possible of energy (green economy) and that people would share (functional economy). In the modern society, it is already possible to buy highly economical cars or to share electric cars in the centre of Paris (autolib'). Unfortunately, nowadays conception, production and consumption of

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the cars (and the majority of fast-moving consumer goods) do not allow to close the loops and achieve CE and sustainable development goals.

From a CE model point of view, there are three main barriers to CE integration (Bihouix, 2014):

1) The "law of thermodynamics". It means that during the recycling process (melting, stoking etc.) there is always a loss of material;

2) The "dispersive use". It means that the utilization of the product disperses its components in the environment and makes a recycling process impossible (fireworks, bombs, cosmetics, inks etc.);

3) The "degradation use". It means that the utilization makes the components of the product impure, making the recycling process impossible (metal alloys, plastics etc.). For example, today the automobile industry requires the use of complex metal alloys (sometimes up to 3000 metals) and plastics, which make them not recyclable. The use of these materials is justified by the need of making the cars less heavy and at the same time still capable of passing the crash test.

From an RRI point of view, which integrates need of sustainability in development strategy, production systems raise two problems:

1) Complicated character of the systems makes a global view of economics impossible. It is necessary to integrate the problem of rebound effects (boomerang effects) and the parameter of energy used by the cars (Jancovici, 2015). Firstly, if new cars consume less than before, it encourages people to use them more actively including news consumers who have not used this type of vehicles yet. Secondly, it is necessary to answer the following questions: what sort of energy is used? Is the energy imported? What are the risks? If electric cars necessitate importation of coal energy, the consequences for the environment could be much worse than before. Finally, introduction of such questions causes new important reflexions in the making decision process and in the development strategy of a company or a country.

2) The role of innovation in the society. Indeed, it is "difficult to define what a desirable and responsible product is" and it is in general left to the market (Weber, & Dewald, 2015). Sustainable objectives must involve a "range of new questions" and a lot of modifications and evolutions in behaviors and mentalities.

Concerning cars, their conception raises a few questions: "should they be regarded as irresponsible because of the number of casualties caused by motorized traffic?[...]What is more desirable in the end: a favorable vision of non-fossil transport or an unspoiled nature?[...]How can undesirable side effects in global value chains be avoided? How can a product like a smartphone or an electric car, which contains hundreds of components, be evaluated under a concept like RRI?" (Weber, & Dewald, 2015).

Private cars produce around 6% of greenhouse gas emissions. To face the problem for example it would be possible to impose 500 kg cars with a 100 km/h flange motor. It could be still possible for people to move and it could notably reduce the greenhouse emissions. The question is to know if all the societal actors and innovators are ready for it, and how RRI would run the "participatory processes in which stakeholders, including citizens and consumers, agree on a new type of product" (Weber, & Dewald, 2015).

According to Bongert (2015), and Albrecht, "RRI programmatic dimensions must meet mental, institutional, and procedural opposition" because "the use of new scientific knowledge, often have grave unintended consequences". In that configuration, the RRI approach has to consider new approaches

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because "public discussions about potential breakthroughs are the exception in capitalism, not the rule" (Weber, & Dewald, 2015).

That is why, human development needs innovation but an innovation with constraints more than ever. One of the main constraints of our time is climate change. The humanity has to contain the global warning less than 2°C till 2100 in comparison to the period of 1880-1899 yrs., while the global warning has already climbed 0.85°C.

The system of innovation has to integrate environmental parameters and rarefaction of resources. Appearance of RRI approach is highly encouraging and could permit such transition. The question is the emergency of the situation faced with a democratic process: "RRI needs to be modified…with regard to solving the grand challenges and be married with complementary, global approaches. Solving global challenges by using "RRI" would mean: Environmental economics has a toolbox for addressing ecological issues…and TA has a toolbox for identifying potential problems" (Weber, & Dewald, 2015).

Environmental economics, including a CE model, seek for a response for a question asked by Owen "what sort of future do we collectively want innovation to create in Europe?" (Owen, & Macnaghten, 2014).

4. Conclusion

Model of circular economy is a model of economics, which was developed in the 1970's and had the purpose to analyse the life cycle of goods and the waste recycling. Today, the model is seen as an instrument to achieve goals of sustainable development.

RRI theory is a new approach, which was developed during the last decade integrating technology assessment theory and other new dimensions such as engagement, governance, anticipation, education, ethics, science, access, gender equality and open access approach. RRI is an interactive process in which all the members of the society aim to achieve common goals of "grand challenges" such as sustainable development.

Both theories are facing problems caused by complex character of a capitalist system born in the 18th century with two first industrial revolutions. In order to be an effective model, circular economy requires very strong and structural changes for the whole society in conception, production and consumption of goods and services. The remarkable fact is that a very few number of goods do not close the loops of the circular economy model.

According to 4'R Theory of the circular economy model, there is no reduction of material use due to production of more complicated goods, which requires more materials. Reutilisation of goods (but not materials) grows in popularity in the society but at the same time remains rather rare. Rehabilitation of goods and materials becomes more complicated because of conception of goods. Overall, it is possible to conclude that recycling of materials is globally possible and practised but has limits, and concerns a very small part of the goods produced.

That is why, governments and companies will have to consider new development strategies and indicators including social and environmental processes having a real impact on economy and wellbeing of society. Meanwhile, consumers will have obligation to cut down on goods consumption and accept the possibility of not owing them anymore.

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These new changes do not exclude social norms and the role of innovation. Innovation has to integrate parameters of "grand challenges" objectives and turn constraints into opportunities. The problem of cognition seems to be the major setback to this process.

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