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AVADA

JOURNAL OF SECURITY AND SUSTAINABILITY ISSUES
ISSN 2029-7017 print/ISSN 2029-7025 online
2016 December Volume 6 Number 2
http://dx.doi.org/10.9770/jssi.2016.6.2(10)

SUSTAINABLE DEVELOPMENT: THE CIRCULAR ECONOMY INDICATORS' SELECTION MODEL

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Received 17 January 2016; accepted 25 May 2016

Abstract. Circular economy conception is a result of development of sustainability. Since 1987, when the World Commission on Environment and Development (WCED) has developed and published the document "Our Common Future", numerous institutions monitor sustainable development (SD) at global, national or regional level. Recently The European Commission adopted a Circular Economy Package, which consists of an EU Action Plan for the Circular Economy that establishes a concrete programme of action, with measures covering the whole cycle and sets out the timeline when the actions will be complete. This paper analyses and tries to answer a question about what should be taking into account setting circular economy indicators.

Keywords: circular economy, sustainable development, EU action plan, circular economy indicators, EU targets

Reference to this paper should be made as follows: Banaitė, D.; Tamošiūnienė, R. 2016. Sustainable development: the circular economy indicators' selection model, *Journal of Security and Sustainability Issues* 6(2) 315–323. DOI: http://dx.doi.org/10.9770/jssi.2016.6.2(10)

JEL Classifications: A13, I31, O11, O13, Q01, Q5, Q56

1. Introduction

Indicators describing circular economy have raised considerable interest throughout the world, but not much conceptual and empirical research exists focusing on development of indicators. Now it becomes important to measure circular economy development, because European Commission tries to help European businesses and consumers to make the transition to a stronger and more circular economy where resources are used several times and in a more sustainable way. In order to achieve this Circular Economy Package has been adopted were actions set contribute to "closing the loop" of product lifecycles through greater recycling and re-use. On the other hand, European Commission does not have any appropriate tools to measure circular economy at macro (national) level.

The article tries to give theoretical model of circular economy indicators selection.

2. Sustainable development

The theory of sustainable development is not very new but it is always in development, because every year world is facing new challenges. The concept of sustainable development has emerged at a time when the topic of the environment is at the forefront of political debate. The roots of the concept of sustainable development rooted in promoting the sustainable use of natural resources. In 1951 International Union for the Nature Con-

servation published the first report on the global environment, which aims to search for reconciliation between economy and ecology. In 1970 the sustainable development concept was created by Barbara Mary Ward. Sustainable development and all three aspects: economic, social and environmental, has become a political objective of the European Union in the Treaty of Amsterdam in 1999 (Duran et al., 2015).

Sustainability derived from Latin word where it means to hold. Hence, sustainable development is also see as a development that meets the needs of the present without compromising the ability of future generations to meet their needs (Ibrahim et al., 2015).

The concept of sustainable development is based on three dimensions of well-being: economic, social and environmental (see Fig. 1). Between sustainable development dimensions occur complex synergies and mutual influence relationships (Cornesc V. and Adam R., 2014).

Indicators have become an important and widely used instrument to evaluate progress towards a more sustainable development (Gerlach et al., 2016).

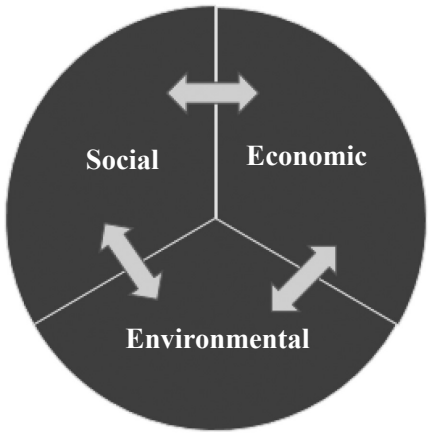

Fig. 1. Dimensions of sustainable development

Source: Cornesc V. and Adam R., 2014

3. Indicators of sustainable development

Indicators for monitoring progress towards sustainable development are needed in order to assist decision-makers and policy-makers at all levels and to increase focus on sustainable development (Čiegis and Štreimikienė, 2005). There are several indicator systems that measures sustainability at macro level:
1. EUROSTAT Sustainable development indicators – 10 groups of indicators;
2. United Nations indicators – 4 themes of indicators;
3. European Environment Agency indicators - 24 main themes;
4. OECD indicators – 10 main groups of indicators,
5. Directorate's - General for Enterprise and Industry indicators (partly) – 7 indicators at Member States level (Grybaitė and Tvaronavičienė, 2007).

Institutional systems revealed a great variety of approaches, emphases, indicators grouping and number of indicators used, so list of indicators should be seen as a flexible list from which countries can choose indicators according to national priorities, problems and targets.

Despite the fact that institutional sustainable development systems are supposed to be composed keeping in mind specific purposes, but scientific practice shows that in order to compare countries it should be set short-list of indicators, otherwise comparisons are hardly performable (Grybaitė and Tvaronavičienė, 2007).

4. Circular economy and evaluation indicators

The concept was introduced in 1976 in a report to the European Commission and it can be seen as a result of implementation of sustainable development worldwide (Banaitė D, 2016).

Historically, circular economy relies upon the principles of 3Rs: Reduce, Reuse and Recycle. It is aimed at optimum production by utilizing reduced natural resources, producing minimum pollutions, emissions and wastes by utilizing the 3R principles (Jawahir, Bradley, 2016). It requires different production and consumption patterns, innovations etc. (Strielkowski 2016; Šimelytė et al. 2016; Shatrevich, Strautmane 2015; Tvaronavičienė 2016; Genys 2016; Rezk et al. 2015; Rezk et al. 2016; Tvaronavičienė et al. 2015; Jurigová et al. 2016; Shevchuk et al. 2016; Petrenko et al. 2016)

Broader model of circular economy consists of eco-design, repair, reuse, refurbishment, remanufacture, product sharing, waste prevention and waste recycling (see Fig. 2).

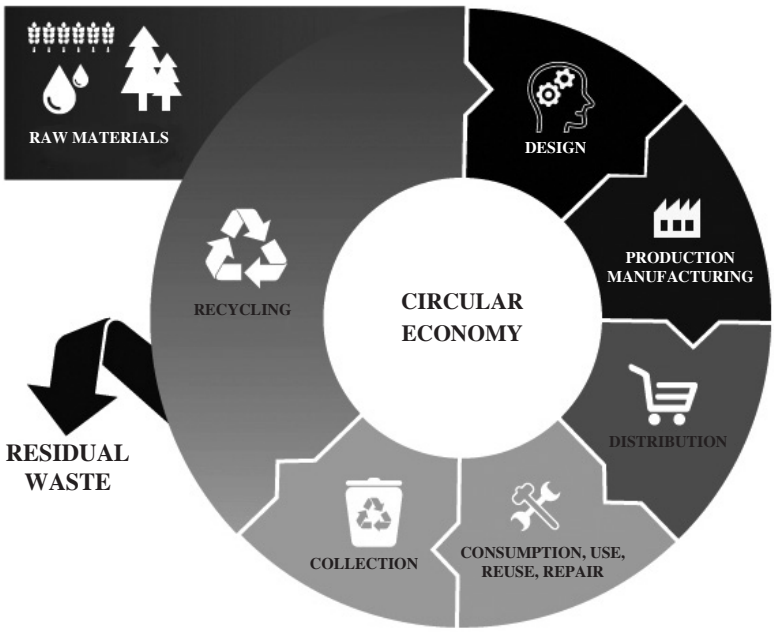

Fig. 2. Circular economy

Source: European Commission

Circular economy also has three main stakeholders:
1. Individual company (industry);
2. Society;
3. Nation, governmental body.

In order to create comprehensive circular economy model of indicators all stakeholders should satisfied all they needs (Fig. 3). It also illustrates a comprehensive framework for CE based on these three perspectives: environmental impact, economic benefit and resource scarcity) including their relationships:

- Economic benefits in CE mean that each individual company strives for gaining economic benefits in order to secure profitability and competitiveness. This requires an integrative approach from business models selection and product design to supply chain design and choice of materials.
- Resource scarcity in CE, it is social prosperity, which depends on planet earth‘s finite resource supplies. It makes regenerative use of resources mandatory for CE realization. The main factors in this context concern circularity of resources, material criticality and volatility of resources in the light of the globally increasing number of industrial activities.

- Environmental impact in CE means that desirable state of nations and governmental bodies is a society with minimum environmental impacts. Circular economy strives to reduce solid waste, landfill and emissions through activities such as reuse, remanufacturing and/or recycling (M. Lieder, A. Rashid, 2016).

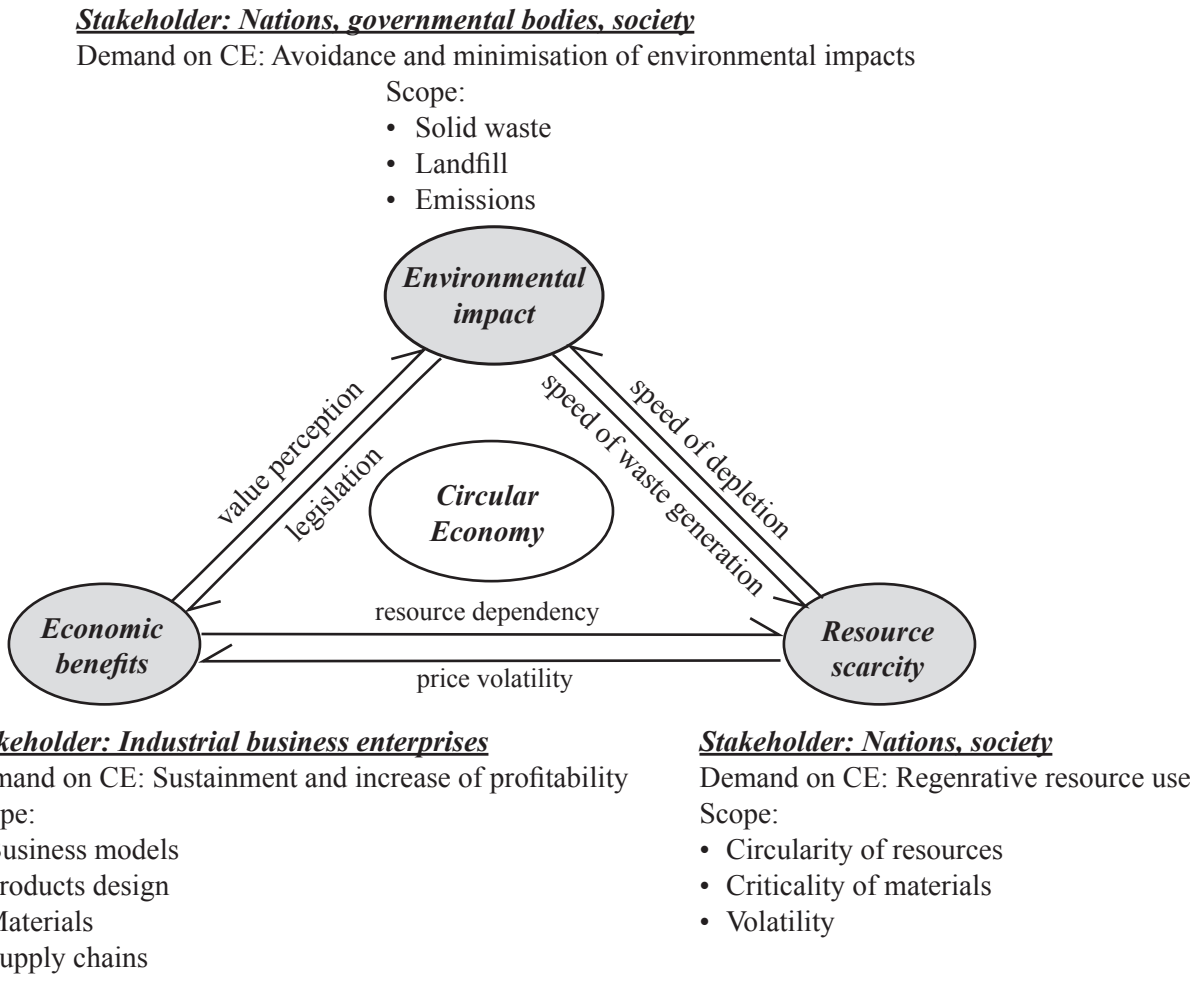

Fig. 3. Circular economy stakeholders and their needs.

Source: Lieder M. and Rashid A, 2016

Analyzing of circular economy evaluation models, it can be seen that not all models meet not just sustainable development dimensions, but even circular economy principles (see Table 1) (Banaitė, 2016).

Analysis of circular economy evaluation models has shown that they have from 8 to 31 individual indicators and all indicators we can group into three main categories:

1. Industry level indicators;

In this level indicators measure:

- Environmental aspects:
  - usage of natural resources in production - the goal is the preservation of natural resources, efficient use of raw materials, water and energy;
  - emission level - direct and indirect emissions;
  - re-usage, recovery and recycling products and materials - the main aim is to prevent waste production, minimizing incineration and landfilling and decreasing energy and material losses (V. Elia et al, 2016);
- Economic aspects - the economic benefit of industry, that refers to the industrial scale and industrial quality;

- Social aspects - the social benefit of industry, which means the increase of the revenue and employment (H. Zhao et al., 2016)

2. Municipal level indicators;

The main target group is household and municipal, so the focus is on consumption, collection and end-of-life resource management (recycling and residual waste management).

3. National level indicators.

Indicators in this level give wider perspective of circular economy at national level:

- Environmental indicators give wider perspective on countries environmental politics, such as resource recycling network coverage, "Three wastes" utilization value in per million GDP, Investment in treatment of industrial pollution and household waste water and garbage, urban public green space area per capita, Forest coverage and so forth. In this aspect indicators, also should measure the effectiveness in different waste sectors such as Waste Electrical and Electronic Equipment (WEEE) (Ghisellini et al, 2016), but there were no such indicators in these analyzed CE evaluation systems.
- Economic and social aspects indicators must show how countries wealth, so usually used indicators are GDP per capita, Unemployment rate, Engel's Coefficient, GDP growth, Meant lifespan and some other.
- Super-efficiency DEA model with 31 individual indicators and Integrative Evaluation on the development of Circular Economy with 26 indicators best fulfills CE and Sustainable development requirement.
- Super-efficiency DEA model use specific efficiency of three sub-systems based on inputs and outputs: resource saving and pollutant reducing, waste reusing and resource recycling and pollution controlling and waste disposing. These sub-systems are assessed along with rank comprehensive CE efficiency (Heshmati A., 2015). DEA model best cover industry and municipal levels, but poorly at national level.

Integrative Evaluation on the development of Circular Economy is based on five aspects which are social and economic development, resource efficiency, resource recycling and reuse, environment protection, pollution reduction, which have from 3 to 9 individual indicators. These indicators give wide perspective and perception about CE at macro level, also best reflect industry, municipal and national level.

EU countries are under control of EU regulations, so countries must meet 4 main quantitative targets that are presented further.

Table 1. Circular economy index evaluation in a context of sustainable development

Circular economy evaluation system	Author(s)	Method of estimation	Categories and coverage of CE and SD	Individual indicators	Circular economy principles			Sustainable development components		
					Reduce	Recycle	Reuse	Economic	Environmental	Social
Regional Circular Economy Development index	Guo-gang J., 2011	Analytic Hierarchy Process (AHP) and Fuzzy Comprehensive Evaluation	1.**Resources consumption** (covers CE reduction principle); 2.**Environmental disturbance** (covers SD environmental component); 3.**Recycling** (covers CE recycle principle); 4.**Social development** (covers SD economic and social components)	16	+	+	-	+	+	+
Super-efficiency DEA model	Wu H.et al., 2014	Data Envelopment Analysis (DEA) window analysis	1.**RSPR sub-system** (covers CE reduce principle, SD environmental, economic and social components); 2.**WRRR sub-system** (covers CE recycle and reuse principles, SD environmental component); 3.**PCWD sub-system** (covers SD social and environmental components)	31	+	+	+	+	+	+
Evaluation of Regional Circular Economy Based on Matter Element Analysis	Chun-ron J. and Jun Z., 2011	Matter element model based on fuzzy weight	1.**Reduce** (covers CE reduction principle); 2.**Recycle** (covers CE recycle principle); 3**.Reuse** (covers CE reuse principle)	10	+	+	+	-	-	-
Integrative Evaluation on the development of Circular Economy	Qing Y.et al., 2011	Principal Component Analysis (PCA) and Analytic Hierarchy Process (AHP)	1.**Social and economic development** (covers SD economic and social components); 2.**Resource efficiency** (covers CE reduction principle); 3.**Resource recycling and reuse** (covers CE recycle and reuse principles); 4.**Environmental protection** (covers SD environmental component); 5.**Pollution reduction** (covers SD environmental component)	26	+	+	+	+	+	+
Material flow analysis (MFA) to evaluate Circular economy	Geng Y. et al., 2012	Material flow analysis	1.**Resource output rate** (covers CE reduction principle); 2. **Resource consumption rate** (covers CE reduction principle); 3.**Integrated resource utilization rate** (covers CE recycle principle); 4.**Waste disposal and pollutant emissions** (covers CE reuse (just partly) principle and SD environmental component)	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	Analytic Hierarchy Process (AHP)	1. **Resource efficiency indicators** (covers CE reduction and reuse principle); 2. **Environment impact indicator** (covers SD environmental component); 3. **Social progress** (covers SD economic and social component)	28	+	-	+	+	+	+

Source: Elaborated by the authors

5. Circular economy and European Union regulations

In 2011 European Commission, has introduced the Communication "Roadmap to a Resource Efficient Europe" and in the late 2015 European Commission adopted an ambitious Circular Economy Package. The Circular Economy Package consists of an EU Action Plan for the Circular Economy and a lot of actions are set.

It was also revised legislative proposals on waste and was set 4 main quantitative targets:
- A common EU target for recycling 65% of municipal waste by 2030;
- A common EU target for recycling 75% of packaging waste by 2030;
- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2030;
- A ban on landfilling of separately collected waste;

These targets also should be considered as indicators. A lot of relevant data collects Eurostat and in addition, the Resource Efficiency Scoreboard (32 indicators) and the Raw Materials Scoreboard (5 indicators for circular economy) are collectig data to monitor circular economy, but it's just splited indicators that do not provide ease understandable information for decision makers.

6. Circular economy indicators selection model and conclusions

The circular economy indicators selection model is presented in Fig 4. This model is Top to bottom model, because European Union targets are obligatory for all member states and all countries have to achieve them. This model shows that indicators of circular economy firstly should meet European Union targets set for circular economy. Targets are the most important setting national/country level indicators.

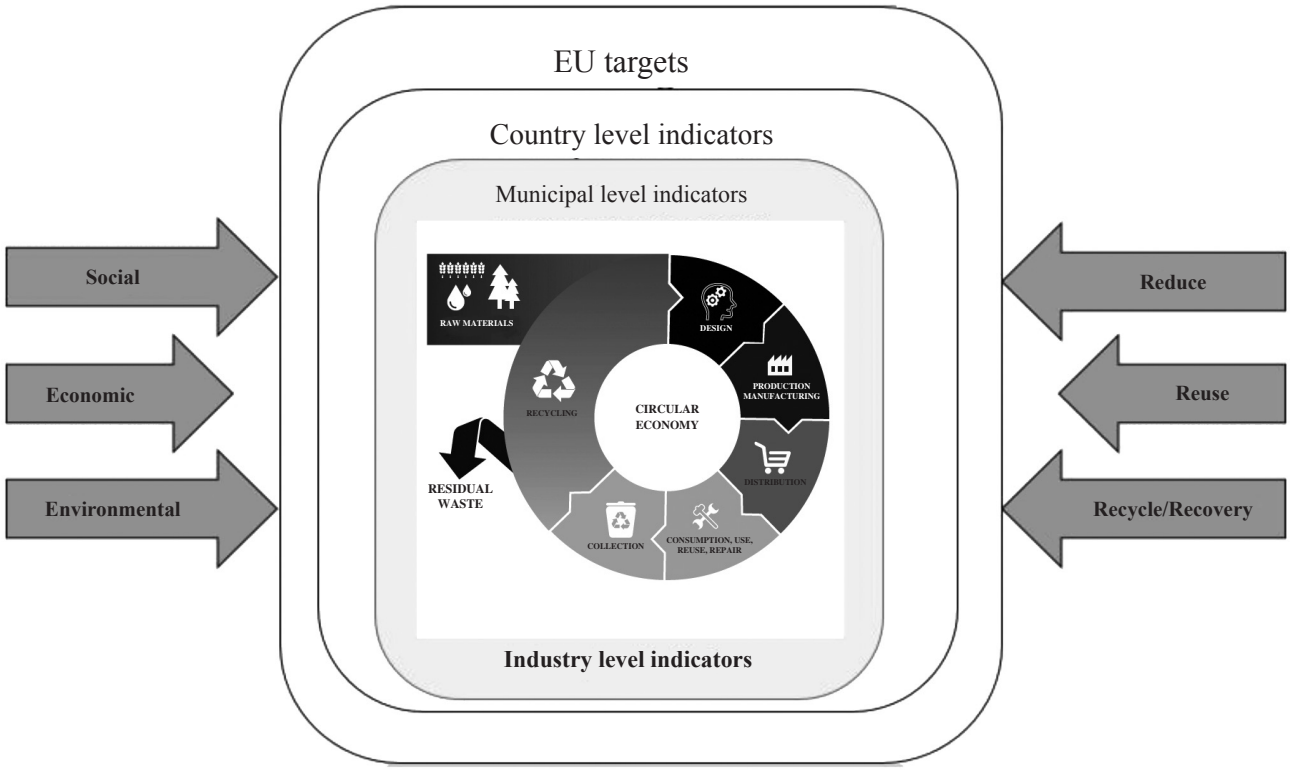

Fig. 4. The circular economy indicators selection model.

Source: Elaborated by the authors

The other layer of indicators should be set from municipal and industry levels. These two levels should cover two main stakeholders (society and business) needs and obligations.

All indicators (national, municipal and industry) should also meet sustainable development dimensions and 3R's principles of circular economy and cover the entire cycle of circular economy.

References

Banaitė D. 2016. Towards circular economy: analysis of indicators in the context of sustainable development. *Social transformations in contemporary society (STICS): proceedings of an international scientific conference for young researchers.* Vilnius: Mykolo Romerio universitetas 2016. p. 142-150. ISSN: 2345-0126

Chen R-H., Lin Y., Tseng M-L. 2015. Multicriteria analysis of sustainable development indicators in the construction minerals industry in China. *Resources Policy* 46, p.123–133

Chun-rong J., Jun Z. 2011. Evaluation of Regional Circular Economy Based on Matter Element Analysis. *Procedia Environmental Sciences* 11, p.637 – 642

Čiegis R., Štreimikienė D. 2005. Integration of Sustainable Development Indicators into Sustainable Development Programmes. *Engineering economics* No 2 (42), p. 7-13

Cornescu V., Adam R. 2013. Considerations regarding the role of indicators used in the analysis and assessment of sustainable development in the E.U. *Procedia Economics and Finance* 8, p.10 – 16

Durana D.C., Gogan A.A.L.M., Duran V. 2015. The objectives of sustainable development - ways to achieve welfare. *Procedia Economics and Finance* 26, p.812 – 817

Elia V., Gnoni M.G., Tornese F. 2016. Measuring circular economy strategies through index methods: A critical analysis. *Journal of Cleaner Production*, p. 1-11

Geng Y., Fu J., Sarkis J., Xue B. 2012. Towards a national circular economy indicator system in China: an evaluation and critical analysis. *Journal of Cleaner Production* 23, 216-224

Genys, D. 2016. Towards sustainable development: tackling relations between energy security and social exclusion, *Journal of Security and Sustainability Issues* 6(1): 27-36. DOI: http://dx.doi.org/10.9770/jssi.2016.6.1(2)

Gerlach J., Richter N., Richter U. J. 2016. Mobility indicators put to test – German strategy for sustainable development needs to be revised. *Transportation Research Procedia* 14, p. 973 – 982

Ghisellini P., Cialani C., Ulgiati S. 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production* 114, p.11-32

Grybaite V., Tvaronavičiene M. 2008. Estimation of sustainable development: Germination on institutional level, *Journal of Business Economics and Management*, 9:4, p.327-334. ISSN: 1611-1699

Guo-gang J. 2011. Empirical Analysis of Regional Circular Economy Development--Study Based on Jiangsu, Heilongjiang, Qinghai Province. *Energy Procedia* 5 125–129

Hák T., Janousková S., Moldan B. 2016. Sustainable Development Goals: A need for relevant indicators. *Ecological Indicators* 60, p.565–573

Heshmati A. 2015. A Review of the Circular Economy and its Implementation. Discussion Paper No. 9611. Sogang University and IZA

Ibrahim F.I., Omar D., Mohamad N.H.N. 2015. Theoretical Review on Sustainable City Indicators in Malaysia. *Procedia - Social and Behavioral Sciences* 202, p.322 – 329

Jurigová, Z.; Tučková, Z.; Kuncová, M. 2016. Economic sustainability as a future phenomenon: moving towards a sustainable hotel industry, *Journal of Security and Sustainability Issues* 6(1): 103-112. DOI: http://dx.doi.org/10.9770/jssi.2016.6.1(7)

Li H., Bao W., Xiu C., Zhang Y., Hongbin Xu H. 2010. Energy conservation and circular economy in China's process industries. *Energy* 35, 4273–4281.

Lieder M., Rashid A. 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner Production* 115, p.36-51

Petrenko, E.; Shevyakova, A.; Zhanibek, Z.; Olefirenko, O. 2016. Towards economic security through diversification: case of Kazakhstan, *Journal of Security and Sustainability Issues* 5(4): 509-518. http://dx.doi.org/10.9770/jssi.2016.5.4(6)

Pupphachai U., Zuidema C. 2017. Sustainability indicators: A tool to generate learning and adaptation in sustainable urban development. *Ecological Indicators* 72, p.784–793

Qing Y., Qiongqiong G., Mingyue C. 2011. Study and Integrative Evaluation on the development of Circular Economy of Shaanxi Province. *Energy Procedia* 5, p. 1568–157

Rezk, M. A.; Ibrahim, H. H.; Radwan, A.; Sakr, M. M.; Tvaronavičienė, M.; Piccinetti, L. 2016. Innovation magnitude of manufacturing industry in Egypt with particular focus on SMEs, *Entrepreneurship and Sustainability Issues* 3(4): 306-318. http://dx.doi.org/10.9770/jesi.2016.3.4(1)

Rezk, M. A.; Ibrahim, H. H.; Tvaronavičienė, M.; Sakr, M. M.; Piccinetti, L. 2015. Measuring innovations in Egypt: case of industry, *Entrepreneurship and Sustainability Issues* 3(1): 47-55. http://dx.doi.org/10.9770/jesi.2015.3.1(4)

Rinne J., Lyytimäki J., Kautto P. 2013. From sustainability to well-being: Lessons learned from the use of sustainable development indicators at national and EU level. *Ecological Indicators* 35, p.35– 42

Sébastien L., Bauler T. 2013. Use and influence of composite indicators for sustainable developmentat the EU-level. *Ecological Indicators* 35, p.3–12

Shatrevich, V.; Strautmane, V. 2015. Industrialisation factors in post-industrial society, *Entrepreneurship and Sustainability Issues* 3(2): 157-172. http://dx.doi.org/10.9770/jesi.2015.3.2(4)

Shevchuk, I.; Khvyshchun, N.; Shubalyi, O.; Shubala, I. 2016. Main trends of regional policy ensuring food security in developed countries, *Journal of Security and Sustainability Issues* 6(1): 125-135. http://dx.doi.org/10.9770/jssi.2016.6.1(9)

Šimelytė, A.; Ševčenko, G.; El Amrani El Idrissi, N.; Monni, S. 2016. Promotion of renewable energy in Morocco, *Entrepreneurship and Sustainability Issues* 3(4): 319-328. http://dx.doi.org/10.9770/jesi.2016.3.4(2)

Štreimikienė D., Baležentis A. 2013. Integrated sustainability index: the case study of Lithuania. *Intellectual economics,* Vol. 7, No. 3(17), p. 289–303. ISSN 1822-803

Strielkowski, W. 2016. Entrepreneurship, sustainability, and solar distributed generation, *Entrepreneurship and Sustainability Issues* 4(1): 9-16. http://dx.doi.org/10.9770/jesi.2016.4.1(1)

Tvaronavičienė, M. 2016. Entrepreneurship and energy consumption patterns: case of households in selected countries, *Entrepreneurship and Sustainability Issues* 4(1): 74-82. http://dx.doi.org/10.9770/jesi.2016.4.1(7)

Tvaronavičienė, M.; Razminienė, K.; Piccinetti, L. 2015. Cluster efficiency study through benchmarking, *Entrepreneurship and Sustainability Issues* 3(2): 120-128. http://dx.doi.org/10.9770/jesi.2015.3.2(0)

Wu H., Shi Y., Xia Q., Zhu W. 2014. Effectiveness of the policy of circular economy in China: A DEA-based analysis for the period of 11th five-year-plan. *Resources, Conservation and Recycling* 83, p.163–175

Zdanyte K., Neverauskas B. 2014. Ensuring of sustainable development for contemporary organizations development. *Economics and management: 2014*. 19 (1). ISSN 2029-9338

Zhao H., Zhao H., Guo S. 2016. Evaluating the comprehensive benefit of eco-industrial parks by employing multi-criteria decision making approach for circular economy. *Journal of Cleaner Production,* p. 1-15

Zhou J., Shen L., Song X., Zhang X. 2015. Selection and modeling sustainable urbanization indicators: A responsibility-based method. *Ecological Indicators 56,* p. 87–95