DETECTING THE LINKAGES BETWEEN CLUSTERS AND CIRCULAR ECONOMY

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Clusters are more often viewed not only as one of the means for small and medium enterprises (SMEs) to achieve competitive advantage through clustering but also as link that enables to focus on resource efficiency challenges and setting up circular value chains. Climate change is at the top of the agenda recently which makes resource efficiency to come under discussion. This paper aims at analyzing circular economy and looking for possibilities to connect business and science so that innovative technologies and products are developed to increase SMEs' resource efficiency through clusters and cluster organizations. Bibliometric literature analysis technique was chosen to qualify circular economy, resource efficiency and clusters, as well as to detect the evidence that clusters can be enablers of resource efficiency and circular economy between SMEs; indicators are introduced to detect these linkages. The findings suggest that the principles of circular economy can be detected between companies within a cluster and resource efficient actions may arise from close cooperation, knowledge transfer, innovative solutions and competitive advantages which are imparted by the cluster. This study needs to be continued to implicate these indicators to test how close cooperation and other advantages that companies can obtain from belonging to a cluster can affect their engagement in circular economy and resource efficiency. These benefits can be used in further development of circular value chains within a cluster.

Keywords: *clusters; circular economy; resource efficiency; knowledge transfer; competitiveness; system of indicators*

JEL classifications: *Q55, R11*

КЛАСТЕРЫ И ЦИРКУЛЯРНАЯ ЭКОНОМИКА: УСТАНАВЛИВАЯ ВЗАИМОСВЯЗИ

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Кластеры чаще рассматриваются не только как одно из средств достижения конкурентного преимущества малыми и средними предприятиями (МСП) посредством кластеризации, но и как связующее звено, позволяющее сосредоточиться на проблемах ресурсоэффективности и налаживать циркулярные цепочки создания ценности. Сегодня изменение климата – в числе приоритетных проблем, что актуализирует дискуссию вокруг эффективности использования ресурсов. Цель данной статьи – анализ циркулярной экономики и поиск возможностей обеспечения связи между бизнесом и наукой для разработки инновационных технологий и продуктов, которые бы способствовали повышению эффективности использования ресурсов МСП посредством кластеров и кластерных организаций. Для получения представления о понятиях циркулярной экономики, эффективности использования ресурсов, кластеров, а также для выявления фактов, свидетельствующих о том, что кластеры могут способствовать повышению эффективности использования ресурсов и циркулярной экономики субъектами МСП авторами выбран библиометрический метод анализа литературы; для выявления этих связей введены определённые индикаторы. Полученные данные свидетельствуют о том, что принципы циркулярной экономики могут быть обнаружены среди компаний, входящих в кластер, а ресурсоэффективные взаимодействия могут возникнуть в результате тесного сотрудничества, передачи знаний, инновационных решений и конкурентных преимуществ, которые способен обеспечить кластер. Предметом для дальнейших исследований может стать применение соответствующих индикаторов в целях проверки того, как тесное сотрудничество и прочие потенциальные преимущества компаний от участия в кластере могут повлиять на их участие в циркулярной экономике и обеспечение ресурсоэффективности. Эти преимущества могут быть использованы для дальнейшего развития циклических цепочек создания ценности в рамках кластера.

***Ключевые слова:** кластеры; циркулярная экономика; эффективность использования ресурсов; передача знаний; конкурентоспособность; система индикаторов*

Introduction

The use of natural resources has increased unprecedentedly in the last hundred years depending on human development. Due to increase of global resource extraction which mostly affected the economic development in Europe, North America and other parts of the world the transition to circular economy becomes a complex task that needs to be maintained by government and require long term to be implemented (Yuan et al., 2008; Čábelková & Strielkowski, 2013; Smol et al., 2015; Kalyugina et al., 2015; Cieślik et al., 2016; Daddi et al., 2017; Linder and Williander 2017; Winans et al., 2017; Dobrovolskienė et al., 2017; Vegera et al., 2018; Lauzadyte-Tutliene et al. 2018; Vegera et al., 2018; Newbery et al. 2018; Mishenin et al., 2018; Yerseitova et al. 2018).

A new ambitious Circular Economy Package has been adopted by the European Commission (European Commission, 2018) which encourages shifting from linear economy to more circular that is stronger for the resources are used in more sustainable way. The benefits will be brought to environment and the economy through the proposed actions which contributes to "closing the loop" of product life cycles though promoting recycling and re-use (Andersen, 2007; Niero & Olsen, 2016).

By definition circular economy is viewed as an industrial system designed or intended to be restorative or regenerative (Mathews & Tan, 2011; Lisin and Strielkowski, 2014; Zlyvko et al. 2014; Lisin et al., 2015; Haas et a., 2015; Čábelková et al., 2015; Strielkowski et al., 2016; Lisin et al., 2016; Hobson, 2016; Štreimikienė et al., 2016; Jiao & Boons, 2017; Murray, Skene & Haynes, 2017; Lisin et al., 2018) and promoted by scholars, policy makers, NGOs, corporations. Global corporations, such as Google, Cisco and Philips, has taken an advantage of this idea even before the European Commission has presented "Closing the loop – An EU action plan for the circular economy" (Hobson et al. 2016; European Commission 2015). Contrary, circular economy is not that easy to implement by small and medium enterprises (SMEs) due to lack of resources, R&D personnel, information systems and other limitations that requires financing (Park et al., 2010; Su et al., 2013; Ehrenberger et al., 2015; Ghisellini et al. 2016; Lewandowski et al., 2016; Rizos et al., 2016; Vaculík et al., 2017; Geissdoerfer et al., 2017).

Clusters as a subject shows its importance through a number of case analysis in various contexts globally and locally. One of the most important advantages for companies belonging to a cluster is very often viewed as competitiveness which is gained through technology transfer (Batkovskiy et al., 2018; Fomina, Berduygina & Shatsky, 2018; Skavronska, 2017; Radwan & Sakr, 2017; Raudeliūnienė et al., 2018; Yang & Černevičiūtė, 2017; Žižka et al., 2018). Clusters naturally are formed regarding to geographical proximity and contribute to regional development through innovations, R&D, start-ups and other activities.

The purpose of this study is to analyse circular economy and review the possibilities to connect business and science so that innovative technologies and products are developed to increase SMEs' resource efficiency through clusters and cluster organizations. Generally, SMEs are not able to become involved into circular economy by their own for they lack knowledge, resources, financing, other components (Koudelková et al., 2015). These limitations can be eliminated by clusters or cluster organizations for companies in clusters gain competitive advantage from being able to integrate into a larger unit and use common properties. Indicators that may help to determine the posibilities of companies belonging to a cluster to be involved in circular economy are suggested in this study. Further analysis should follow this study to implicate the indicators and test how close cooperation and other advantages that companies obtain from belonging to a cluster can affect their engagement in circular economy and resource efficiency. These benefits can be used in further development of circular value chains within a cluster. Bibliometric analysis was apllied to identify the trends of circular economy and how it is viewed through clusters.

The article is structured as follows. In the second section there is a describtion of the research design and the method of data collection. The third section gives literature

review of circular economy. The fourth section shows the observations on cluster theory. The fifth section defines how clusters can affect SMEs in circular economy. The last section incorporates the conclusive remarks.

Data and methodology

Web of Science database was chosen to search for the articles to use for literature analysis in this paper. This database contains the world leading scholarly literature in different categories The articles were selected according to the times they were cited and and usage count.

Some restrictions were applied while selecting the articles. Three types of keywords were selected in search: circular economy, cluster and circular economy cluster. These keywords may appear in different contexts, for this reason, articles were double – reviewed manually after an automatic search results were suggested. The final results are composed after a close inspection to make sure the articles comply with the purpose of the study and can add important impormation to make the research beneficial for concerned parties and enable continuation of the study.

Traditional bibliometric analysis technique allows identifying different aspects of circular economy and clusters that are discussed by scholars. As a result, 4 groups of indicators regarding circular economy were structured which includes 15 indicators to supplement clusters performance evaluation system of indicators. These groups are given later in the paper

Approaches towards circular economy

There are numerous articles about circular economy that emphasize the growing interest in the field. The concept is studied in various contexts through different angles. Here, some trends are noted and several articles are taken for closer review. Examples of literature analysis, case analysis or more complex assessment are taken into consideration to present a general image of how circular economy is studied in literature. Table 1 gives some notes of authors that are interested in the field and give significant suggestions for further analysis. These articles are selected according to the usage count in Web of Science database.

Table 1

Approaches towards circular economy

Authors	General observations
(Merli, Preziosi, & Acampora, 2018)	Waste management emerges as the most relevant sub-sector in circular economy
(Wen & Meng, 2015)	Resourse productivity is a suitable index for the quantitative assessment of industrial symbiosis to promote circular economy
(Nizami et al., 2017)	Waste biorefineries in developing countries
(Hobson & Lynch, 2016)	Regenerate, Share, Optimize, Loop, Virtualize and Exchange
(Andersen, 2007)	basic welfare economic functions: (1) amenity values; (2) a resource base for the economy; (3) a sink for residual flows; (4) a life- support system
(Witjes & Lozano, 2016)	collaboration between procurers and suppliers can lead to reductions in raw material utilisation and waste generation
(Korhonen, Honkasalo, & Seppälä, 2018)	Sustainable development as a basic point for the definition of circular economy

Source: *authors' compilation.*

An extensive literature analysis referring to articles from Web of Science and Scopus databases given by Merli et al. (2018) provides an overview on how scholars deal with the topic of circular economy. The studies in circular economy are concentrated in China and Europe for there is public policies implementation offered. Scholars view circular economy at a macro level of analysis (country, region, or city), at a micro level for its operationalization in single firms, and at a meso level for the implementation of industrial symbiosis. This concept has blurred boundaries for there is no clear definition or common agreement on the guiding principles for action which allows to associate circular economy with variety of other disciplines that define its roots. Scholars should pay more attention to new approaches to production and consumption for there has been a lack of consideration toward circular design and innovative strategies to slow material and resource loops. Value-focused innovative practices, which embody circular economy philosophy, such as sharing economy, product-service systems, dematerialization, remanufacturing should be further explored by academia. Circular economy is growing as a concept that may open the path toward innovative and sustainable ways of production and consumption.

Liu & Bai (2014) emphasize that companies usually have a good general understanding of the circular economy, a positive view of it and a relatively strong willingness to operate it. However, companies lack enthusiasm to adopt the principles of circular economy. The knowledge about the positive effects of circular economy implementation does not encourage companies to actually work on that for some structural, contextual and cultural reasons.

Policy makers focus on the regulations to overcome the barriers and engage companies to operate in circular economy. Initiatives should encourage companies to establish eco-industrial chains. Environmental pressure from competing companies and customers does not affect companies' behavior in shifting to circular economy.

Wen & Meng (2015) provide a substance flow analysis and resource productivity which was jointly applied to quantitatively evaluate the circular economy performance of industry in China. The substance is able to exit the system at multiple stages in the production chain and the complicated relationship between enterprises which makes the substance flow analysis at the industrial chain level extremely challenging. The research has shown that the resource productivity is higher of the chain that includes waste utilization rather than that which excludes waste utilization. Resource productivity can be enhanced by applying several properties: prolonging industrial chains, connecting chains-matching projects with recycling companies, designing eco-industrial chains and setting industrial symbiosis system.

Industrial symbiosis system can improve the resources and energy productivity of industrial systems by reducing material consumption and waste discharge to result in huge economic and environmental benefits. The same economic output can be achieved by less resource consumption as proven by improved resourse productivity. Utilization efficiency of resources and energy can be reflected by resource productivity which makes it a suitable index for the promotion of circular economy and quantitative assessment of industrial symbioses.

Public and political attention can easily be attracted using catchy framework and wor circular economy such phrases as regenerate, share, optimize, loop, virtualize and exchange serve the purpose (Hobson & Lynch, 2016). The problem with these word according to the authors is the aspect that they are gaining new meaning in the context of circular economy but misses out the social and cultural aspects. The meaning of phrases incorporated in the definotion of circular economy require further exploration and expansion for they are offering non-monetary forms of sharing goods, ideas and experiences.

Social and political facets of the circular economy lacks greater consideration. The consumer limited and problematic means of engaging with the issues at the heart of the CE, such as responding to environmental labels or renting rather than buying goods: neither of which are strategies that have to date brought about desired widespread adoption of 'sustainable lifestyles'. Here, the point is made about circular economy debates that must include questions of the social, the citizen and consumption, which includes broadening the ontological toolkit CE debates, interventions and policies draw upon to include notions of diverse economies and post-capitalism.

A comprehensive attempt to make sense of the actual concept of the circular economyis provided in scientific research (Korhonen et al., 2018). All three dimensions of sustainable development are highlighted: economic, environmental and social. Circular economy concept contributes to the importance of high value and high quality material cycles in a new manner and shows the possibilities of the sharing economy along- side sustainable production for a more sustainable production- consumption culture.

Park et al. (2010) state that integration of business value elements can be a guide for organizations to gain competitive advantage, while looking at the broader perspective of supply chains and eco-industrial parks. Sustainability within supply chains take on a more important role as supply chain competitive advantage, rather than individual organizational competitive advantage, becomes more important. Relationships within and between organizations in a CE economy can be quantified by developing formal models and simulations.

Clusters in literature

Clusters' members are connected by economic interests though participation in the activities of product or service value creation chains in which sense clusters differ from other cooperation forms. Clusters are more than simple horizontal networks, which are typical for companies working in the same market or depend to the same industry group, cooperation in such areas as R&D, innovations, product creation or purchase policy. More generally, clusters are cross-sectoral (vertical and/or horizontal) networks, composed of different companies, which supplement each other, science and education institutions and other subjects which can provide reasonable solutions in cluster value creation chain. Cluster's members can efficiently create products or services in accordance to actively participating clusters' facilitators, who help to find common cross-sectorial cooperation contacts and develop them.

Table 2

Sectors that are analyzed by scholars in scientific literature

Type	Authors	More specific	Authors
Industry	(Alcácer & Chung, 2014; Boschma, Minondo, & Navarro, 2013; Funk, 2014; Isaksen, 2015; Lai, Hsu, Lin, Chen, & Lin, 2014; A. Zhang & Huang, 2012; S. Zhu, He, & Liu, 2014)	Multinational companies, global cluster networks and global city-region networks	(Bathelt & Li, 2014)
		Garment clusters, clothing industry	(Carswell, 2013; Carswell & De Neve, 2013; Smith, Pickles, Bu ek, Pastor, & Begg, 2014)
		Footwear cluster	(Casanueva, Castro, & Galán, 2013)
		Auto parts, automotive industry	(Corredoira & McDermott, 2014; Schmitt & Van Biesebroeck, 2013)
		Manufacturing companies	(D'Angelo, Majocchi, Zucchella, & Buck, 2013; Tessitore, Daddi, & Frey, 2012)
		High-tech sector	(Fallah, Partridge, & Rickman, 2014)
		Agriculture — community gardens and farmers' gardens	(Wang, Qiu, & Swallow, 2014)
		Food and beverage – wine clusters	(Giuliani, 2013)
		Universities and industry	(D'Este, Guy, & Iammarino, 2013)
		Global video game industry	(De Vaan et al., 2013)
		Creative clusters	(Zheng, 2011)
		New industries	(Tanner, 2014)
Services		Customer clusters	(Bindroo, Mariadoss, & Pillai, 2012)
		Business clusters	(Helsley & Strange, 2014)

Source: authors' compilation.

Literature analysis reveals that clusters and cluster organizations are sector sensitive. The previous studies (Razminienė, Tvaronavičienė & Zemlickienė, 2016; Tvaronavičienė, Razminienė & Piccinetti, 2015; Tvaronavičienė, 2017) showed that every cluster differs depending on its sector. Therefore, involvement in circular economy should be measured according to the industry or type of activity for it is impossible to apply a universal model. The characteristics of each individual company within an industry may be very different from each other and the engagement in circular economy may be defined with varying degrees of importance by different companies. Authors that are interested in the clusters and analyze them from different perspectives are given in Table 2 according to the type of sector that clusters belong to in their scientific papers. These articles are selected according to the times cited in Web of Science database.

De Vaan, Boschma & Frenken (2013) identify that recent empirical evidence shows that companies in clusters do not outperform companies outside clusters and spatial clustering based on localization externalities is being questioned. This study finds that in the global video game industry the net effect of clustering becomes positive after a cluster reaches critical size. Two hazard models are used to test the hypothesis concerning failure and acquisition. The study suggests that studies in economic geography should be more sensitive to industry specificities for they are reflected in the exact nature of localization externalities and different modes of performance.

Tanner (2014) presents a study that considers the emergence of new industries. Literature analysis, patent data and qualitative interviews reveal that some regional diversification processes occur in regions where pre-existing economic activities are not technologically related to the emerging industry.

The study by Zheng (2011) shows the impact of "creative clusters" on urban entrepreneurialism in China. The main concern is that even though these clusters are playing an important role by attracting business, they are not productive at fostering talent or boosting entrepreneurship of creative industry itself.

Literature suggests that circular economy is very important and promising concept for it atracted business community to more sustainable development. Circular economy is very important in clusters development for it may appear as one of the greatest competitive advantages. This can be applicable to different units, individual companies, or clusters. Clusters emphasize the importance of competitive advantage in their activity for this reason the involvement into circular economy should be emphasised for individual companies in clusters and for a cluster as a unit.

It is impossible to find one clusters' development model, which could be applicable to everyone. There are different clusters' development forms, some clusters change their specialization, others may be simply replaced by newly emerging clusters. Clusters emerge naturally in developed economies and use cluster as the form of organization of business activities, which enhance economic efficiency of product and service added value by cooperation of companies and other institutions as well as increasing the competitiveness of companies.

Selected indicators for evaluation of clusters' competitiveness through circular economy

Governments should be concerned about clusters for the main focus of clusters' development may refer to enhancement of the competitiveness of economy by encouraging and improving clustering.

These aspects can be ascribed for clusters' development:
- To develop clusters' innovative potential;
- To encourage the export of products created by cluster's members and connection to international value chains;
- To enhance the efficiency of the activities of cluster's members;

- To form a friendly environment for clusters' establishment, activities and development (ecosystem);
- To encourage cross-sectorial, interregional and international cooperation;
- To spread the benefits and potential of clustering;
- To encourage SMEs for resource efficiency through clustering.

In the national level clusters usually are not able to compare their performance for there is no system created to serve this purpose. The close analysis of the indicators of cluster performance would enable cluster evaluation tool formation for cluster performance evaluation in national level. There were several preceding attempts by the authors to compose a system of indicators for clusters' efficiency evaluation in the national level by identifying indicators and apllying benchmarking technique to verify the reliability of the methodology. A system of indicators which was previously suggested by the authors (Razminienė & Tvaronavičienė, 2018; Razminienė et al., 2016; Tvaronavičienė et al., 2015) needs to be supplemented by including indicators that enable to identify how engagement into circular economy adds to competitiveness of the companies belonging to the cluster.

Resource efficiency is getting more interest in Europe and globally for companies understand the importance of this concern (Shahbazi, Wiktorsson, Kurdve, Jönsson, & Bjelkemyr, 2016). This topic has been escalated by environment – oriented clusters and many have adopted circular economy as their specific focus to help SMEs learn about circular economy and resource efficiency through initiated projects. Clusters are very important agents for they are able to demonstrate how SMEs can become more resource efficient, innovative and gain competitive advantage. Circular value chains may be developed by companies for usually clusters are composed of companies that represent a value chain and may cultivate links to corresponding partners.

There have been attempts to evaluate circular economy cluster development using objective information entropy and subjective AHP model (Zhang, Wang & Hong, 2013), green supply chain performance (Jun, 2009; Zhu, Geng & Lai, 2010), although these studies need to be further improved and require deeper analysis. Industrial symbiosis in a form of eco-industry that represents resourse flows of geographically clustered companies and is studied by scholars from circular economy point of view (Daddi et al., 2017; Yu, Han & Cui, 2015; Zhang, Yuan, Bi, Zhang & Liu, 2010). Eco – industrial parks may have developed from standard industrial parks but still encounter with barriers of development (Bellantuono, Carbonara & Pontrandolfo, 2017; Geng, Fu, Sarkis & Xue, 2012; Shi, Chertow, & Song, 2010; Zhu, Geng, Sarkis & Lai, 2015).

Regarding the literature analysis of clusters performance and circular economy (Genovese, Acquaye, Figueroa & Koh, 2017; Kazancoglu, Kazancoglu & Sagnak, 2018; Mesa, Esparragoza & Maury, 2018), a four level structure of indicators was suggested including environmental performance, economic / financial performance, operational performance and organizational performance (Figure 1). Indicators for evaluation of clusters' competitiveness through circular economy were pre-selected after literature analysis, then approved by experts that allows single out 15 indicators from the above named four areas and compose a secondary structure for evaluation index (Table 2).
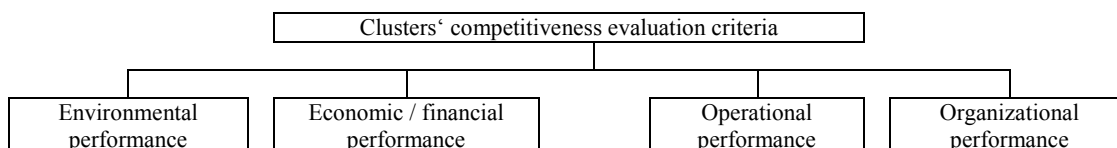

Figure 1. The main criteria of selecting indicators for evaluation of clusters'
competitiveness through circular economy
Source: authors' compilation.

Table 3

Indicators for evaluation of clusters' competitiveness through circular economy

Environmental performance	Usage of Alternative Energy Sources
	Solid Waste
	Liquid/Water Waste
	Percent of Materials Recycled or Reused
Economic/financial performance	Labor Cost per Hour
	Average Profit from Green Products
	Average Return on Investment from Green Products
Operational performance	Use of Recyclable Materials in Production
	Use of Recycled Materials in Production
	Cooperation with Customers for Green Production
	Life Cycle Assessment
Organizational performance	Green initiatives and eco-service
	Keeping the website updated on environmental issues
	Accurate and prompt information exchange between trading partners
	After sales service performance

Source: *authors' compilation.*

The main aim of clusters' monitoring is to create conditions to adopt evidence-based solutions in order to improve the competitiveness of economy through promoted and efficient clustering. Agency for Science, Innovation and Technology (MITA) is responsible for monitoring and evaluation of clustering in Lithuania. Curently this agency is working as a coordinator on implementation of the project „Promotion and Development of Innovation Networking (InoLink), which is funded by the European Fund for Regional Development. Lithuanian Innovation Centre (LIC) works in accordance to implement the project. The main aim of the project is to encourage companies to merge into clusters, to increase cluster maturity, to promote growth and international collaboration (KlasterLT, 2018). During a discussion with InoLink project manager it was agreed upon including the suggested indicators into quastionaire that will be submitted to clusters. The indicators for evaluation of clusters' competitiveness through circular economy will be included in the methodology of clusters' performance monitoring which is being carried out by MITA.

Conclusions

Research on clusters gained its popularity in various academic fields such as management and strategy, regional development and growth, urban studies and economic geography since 1990. Today we encounter many well-developed clusters which demonstrate significant competitive advantages for the companies in the cluster and strong performance for the region. However, the successful development of a cluster may be rather challenging.

Resource efficiency is becoming more important for SMEs, they are interested in reduction of energy, material and water costs and they start looking at circular business models to turn their waste into assets. Clusters and clusters organizations can play a huge role in SMEs becoming more resource efficient. Competitive advantage is what makes companies to cooperate in clusters. Circular economy may help companies to achieve this goal for clusters are able to connect corresponding parties to be involved into resource efficiency, recycling, re-use of materials and other activities within a unit. The necessity of cluster performance evaluation is captured in a national level in order to identify weaknesses

and strengths for further development and improvement of a cluster. Cluster performance evaluation tool with regard to circular economy would enable clusters' evaluation in national level.

Bibliometric analysis technique was chosen to trace the trends of circular economy analysis, review how clusters are explored and which sectors are mostly investigated by scholars. The findings suggest that circular economy could be encouraged by clusters and cluster organizations for it adds to a competitive advantage of companies within a unit. Additional indicators were selected regarding circular economy to complement clusters performance evalution indicators that were previously suggested by the authors (Razminienė & Tvaronavičienė, 2018; Razminienė et al., 2016). A complete system of indicators, including those of circular economy, will allow clusters, cluster organizations, companies and policy makers to observe the effect of clusters activities regarding circular economy.

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