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Local contribution to circular economy. A case study of a Polish rural municipality

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Summary: The concept of circular economy is becoming increasingly important not only for academics, but also for other stakeholders. Notably the local government representatives are implementing such solutions, in response for the population growth and development, connected with increased consumption. This paper aims to recognize existing local solutions of circular economy as well as to identify possible ways for its development. Mixed methodology is used, including constructive approach, SWOT analysis, descriptive statistics or weak-market test. An analysis emphasizes a positive impact of circular economy on local development of the investigated municipality. However, it is still necessary to continue and intensify information and education activities for increasing public awareness of waste prevention, their removal under communal waste collection and collection systems, and proper management of municipal waste (especially biodegradable waste).

Key words: circular economy, waste management, sustainable development, technological innovation, waste-to-energy.

JEL codes: Q53, R58, O13

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Introduction

Circular economy has been gaining more and more attention among academics and practitioners during the last decade. Increasingly, the main emphasis has been put on global problems and solutions aimed at improving the situation from a perspective of use of natural resources and recycling of materials. From this perspective a local approach, focusing on solving problems related to the re-use of raw materials and waste, can be not stressed enough or even omitted. That is why we would like to investigate opportunities for starting internal loops of the circular economy at the local level. The case study selected represents a rural municipality located in the area of intensive agricultural production, peripheral from a perspective of an administrational region but characterized by environmental features of high value. The work aims to recognize existing local solutions of circular economy as well as to identify possible ways for its development. Closing loops in local systems can contribute to solving problems at the regional level and in the global systems. In the study, we map the conditions of the municipality development as well as problems of raw materials and waste management. An analysis of statistical data and focus discussion involving representatives of local authorities, entrepreneurs, farmers as well as individuals and social organizations proves a need to look for business models that will help solve problems of municipal waste, water and sewage management.

1. Background

The increase in population and rising consumption related entails growing problems regarding waste production and scarcity of natural resources. For this reason, solutions aimed at reducing waste and recycling development as well as at re-use of materials have been becoming increasingly important. In this context, the concept of circular economy has been attracting more and more attention from politics, science, business and civil society. An analysis of 114 definitions led Kircher *et al.* (2017) to define circular economy as an economic system that replaces the "end-of-life" concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes. What is important to stress from the perspective of the study, the circular system operates at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond). This kind of approach is related with a few principles, of which the most important ones can be defined as following (EMAF, 2012):

1. products are designed and optimized for a cycle of disassembly and reuse. These tight component and product cycles define the circular economy and set it apart from disposal and even recycling where large amounts of embedded energy and labor are lost;
2. a strict differentiation between consumable and durable components of a product. Consumables are largely made of biological ingredients or 'nutrients' that are at least non-toxic and possibly even beneficial, and can be safely returned to the biosphere - directly or in a cascade of consecutive uses. Durables, such as engines or computers are made of technical nutrients unsuitable for the biosphere (e.g. metals, plastics), which are designed from the start for reuse;
3. the energy required to fuel a cycle should be renewable by nature, again to decrease resource dependence and increase system resilience (e.g., to oil shocks).

Circular economy (CE) is a concept currently promoted by some European Union Member States and several other countries, including China, Japan, Canada, as well as several companies around the world (Korhonen *et al.*, 2018a). The concept of circular economy has been expressed in the EU policy. In the program 'Towards a circular economy. A zero waste program for Europe' adopted in 2014, the European Commission states that Europe can benefit economically and environmentally from better use of resources (EC, 2014).

Since the industrial revolution, the "take, produce, consume and discard" growth model has been consolidated in economy. It is a linear approach based on the assumption that resources come in abundant quantities, are available, easily obtainable and can be removed at a low cost. However, problems related to access to natural resources and the amount of waste generated are forcing a search for new models of economic development (Korhonen *et al.*, 2018b). Circular economy systems allow in this context to keep the added value of products and eliminate waste as long as possible. The transition to circular economy requires change at every link in the value chain, from product design to new business and market models, from new ways of transforming waste into new consumer behaviour (Lokesh *et al.*, 2018). The main areas for change within circular economy are production, consumption and waste management (EC, 2015).

Circular economy starts at the very beginning of the product life cycle. Both the design and production stages have an impact on the processes of obtaining raw materials, using resources and producing waste throughout the product's life cycle. Thanks to better design, products can be more durable or easier to repair, modernize or regenerate (Bocken *et al.*, 2016). Better design can help recycling companies to dismantle products in order to recover valuable materials and components. Even in the case of products or

materials designed in a smart way, inefficient use of resources in production processes may lead to the loss of business opportunities and the production of a significant amount of waste. In this context, attention should be paid to the environmental and social impact of production, both in the EU and in third countries. Joint actions and support from all stakeholders are necessary to effectively implement the large-scale CE concept (Lieder & Rashid, 2016).

Consumption is the second area of implementation of circular economy. Choices made by millions of consumers can support or hamper the development of circular economy. This stage is also crucial for preventing and reducing household waste. Circular economy strategies are crucial for restructuring the take-make-dispose model through the active participation of all actors of supply chains (Borrello *et al*., 2017).

Waste management is the third component of circular economy. It plays a key role through determining how the waste hierarchy is applied in practice. The waste hierarchy sets the order according to priority: from prevention, preparation for reuse, recycling and recovery of energy to disposal, such as landfilling. This principle aims to encourage the use of options that bring the best overall environmental effect (EC, 2017). The way we collect and manage waste can lead to high recycling rates and make valuable materials return to the economy, or it can result in an inefficient system where most recyclable waste goes to landfills or to incinerators, which it may have harmful effects on the environment and cause significant economic losses. This is partly because in practice the material collection system in place is waste management, rather than manufacturing-centered take-back systems (Singh & Ordoñez, 2016).

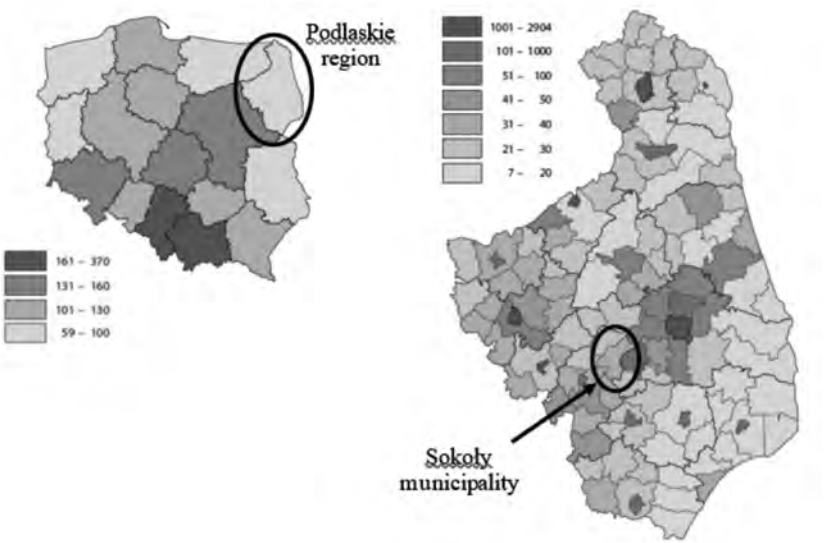
As waste management is in fact organized by municipalities, this level of investigation seems to be an appropriate one in the study of local contribution to circular economy. Municipalities represent both a public policy entity and a key managerial unit and as Agovino *et al.* (2019) indicate, a more recent strand of the literature shifts the focus of the research on the degree of efficiency of waste collection from households to administrative units.

2. Materials and methods

Sokoły rural municipality is a case study selected to recognize existing local solutions of circular economy as well as to identify possible ways for its development. It is located in the Western Functional Area of the Podlaskie Region (north-eastern part of Poland). The eastern border of the region is also the Polish border with Lithuania and Belarus. According to the data of the Central Statistical Office, at the end of 2015, this region was inhabited by 1,188,800 people, with the population density respectively 59 people /

km^2, making up less than half of the national average (123 people / km^2) (Figure 1). The settlement network covers 40 cities, inhabited by 60.4% of the province's population, of which small units with less than 10,000 of population are dominant. The leading role is played by Białystok, numbering 295.98 thousand residents according to the state at the end of 2015, being the capital and largest city of the region.

Figure 1 - Population density in Poland, Podlaskie region and Sokołów municipality (persons / km^2)



Source: own based on: Statistical Atlas of Podlaskie Voivodship 2018. Statistical Office in Białystok - Podlaski Regional Research Centre, Białystok.

In 2015, the regional structure of land use was dominated by arable lands (60.1%), followed by forested and wooded lands (31.9%) in terms of area occupied, wasteland engaged 2.7% of the area of the region, land under waters - 1,4%, while built-up and urbanized lands - 3.7%. The forest cover of the region in 2015 was 31.2% and was slightly higher than the national average (30%) (Podlaskie, 2016).

Podlaskie region is characterized by the highest share of national parks and the second in terms of NATURA 2000[1] areas in the total area (the area

1. NATURA 2000 is a network of nature protected areas program on the territory of the European Union aiming at preservation of specific types of natural habitats and species that are considered valuable and endangered across Europe. It is based on two EU directives -

of national parks represents almost 30% of all areas of national parks in Poland). Legally protected areas in 2014 occupied 32% of its territory (645,1 thousand ha). The system of protected areas of the voivodship consists of: 4 national parks (Białowieża, Biebrza, Narew and Wigry), 93 nature reserves, 3 landscape parks, 15 protected landscape areas, 2 documentation sites, 271 ecological sites, 1998 nature monuments, 5 nature-related complexes landscape, 36 Natura 2000 areas. This region is well-known in the country and Europe because of its unique natural and landscape values, making it very attractive in terms of tourism. The entire region is located in the functional area of the Green Lungs of Poland. The Sokoły municipality is situated in its central part. It consists of 48 villages and covers 156 km^2.

Table 1 - Basic characteristics Sokoły municipality

Specification	**2014**	**2015**	**2016**
Population	5826	5804	5790
Population per 1 km^2	37	37	37
Non-working age population per 100 people of working age	60.7	61.4	61.4
Forest area % of total land area	19.6	19.6	19.5
Employed people per 1000 population*	81	78	75
Population (%) using: water supply system	93.4	93.4	93.5
sewerage system	23.2	23.4	23.4
gas system	0.6	0.6	0.6

* Excluding economic entities employing up to 9 persons and individual farms in agriculture.

Source: Statistical vademecum for local self-governments, https://stat.gov.pl/statystyka-regionalna/statystyczne-vademecum-samorzadowca/ (accessed 03.02.2019).

In accordance with the design science vision, constructive research (CR) was chosen as the key research methodology, mainly for practical motives. CR is usually observed as a case-study technique which targets to find solutions to prearranged problems (Aaltonen *et al*., 2006). The important feature of CR is the generation of innovative information about the objective area. As stated by Kasanen *et al.* (1993), defining a practically appropriate research problem, attaining a broad and complete understanding of the

the Birds Directive, adopted in 1979, and then replaced by the 2009 Directive and the 1992 Habitats Directive. In 2016, the entire Natura 2000 network has over 27000 areas about 1,150,000 km2 both on land and marine areas, which is around 18% of the area of European Union countries (EC, 2018).

subject matter, as well as innovating and creating an academically grounded solution are essential phases in the constructive research approach (CRA). In the concluding steps of the CRA, the established solution ought to be evaluated and verified through an investigation of its applicability and a diagram of its theoretical influences as well as research input (Kasanen *et al.*, 1993). Figure 2 illustrates the relations between different elements of CRA. Oyegoke (2011) related this method to the modern reality and further developed this model.

Figure 2 - Elements of constructive approach

Source: Kasanen *et al.* (1993)

The constructive approach can be described by separating the research process into phases, with the note that the order of which might differ from case to case (Kasanen *et al.*, 1991):

1. Define a practically applicable problem which also has exploration potential.
2. Acquire an overall and comprehensive understanding of the subject matter.
3. Innovate, i.e., create a clarification idea.
4. Prove that the solution is applicable.
5. Demonstrate the theoretical relations and the research contribution of the concept.
6. Scrutinize the range of applicability of the solution.

Nonetheless, the definite practicality of a managerial solution is never proved before an applied examination is passed. Hence the main criterion to evaluate the outcomes of functional studies is their concrete usefulness, which increases the issues of the significance, simplicity and easiness of operation of those effects (Niiniluoto, 1984).

Kasanen (1986), in his dissertation implementing the constructive approach, uses an example for market-based validation of managerial solutions, arguing that the whole process is time-consuming and necessitates

a number of attempts of application. The following market tests are established on the conception of innovation diffusion, i.e., managerial constructions are regarded as products competing in the market of solution concepts.

- **Weak market test**: Has any manager accountable for the financial outcomes of his or her business unit been eager to apply the construction in question in his or her definite decision making?
- **Semi-strong market test**: Has the construction become extensively implemented by companies?
- **Strong market test**: Have the business units applying the construction systematically created improved financial results than those which are not using it?

It should be highlighted that even the weak market test is reasonably strict – it is perhaps not often that an uncertain construction is capable to pass it. For instance, there is no lack of formal optimization models which allegedly solve managerial control problems however which no one is using in practice (Kaasanen *et al.*, 1993).

It should be emphasized that in our case we are able to perform weak market test only, since this is a preliminary phase of research and business implementation. Moreover, this research is based on few experts' opinions, which have been presented and confronted with the views of municipality's representatives. It was done during three study visits of members of the research team in the investigated municipality in autumn 2018 and winter 2019. Therefore, there is a strong necessity to get deeper into a specification of this project, by e.g. performing numerous feasibility studies. Nevertheless, a certain level of insight was possible after numerous business meetings. In result, we were able to perform a specific form of preliminary analysis of various aspects of further development of the investigated municipality.

We have also applied a SWOT analysis grid, which is commonly used by numerous experts, marketing scientists, and is a frequent and widespread instrument. Its minimalism and catchy acronym propagates its implementation in business and beyond since the tool is used to evaluate alternatives and complex decision conditions. It can benefit from various viewpoints as a brainstorming exercise. SWOT analysis helps in the identification of environmental interactions as well as the development of appropriate conduits for organizations, countries, or other entities to follow (Proctor, 1992).

The main usages of a SWOT analysis by community organizations are as follows: to organize information, provide understanding into obstacles that might be met while engaging in social transformation procedures, and recognize existing strengths that can be initiated to overcome these barriers (Chermack & Kasshanna, 2007). Bearing in mind the fact that the SWOT

analysis is a snapshot of the situation at a specific moment in time, it should be perceived and taken into consideration that both the internal and external circumstances of every entity are continuously modifying (Menon *et al.*, 1999).

3. Results

3.1. *SWOT analysis*

Table 2 presents results of the SWOT analysis of the investigated Sokoły municipality. It has helped us determining the strengths, weaknesses, opportunities and threats of the region in order to emphasize its quite unique investment incentives, which can be applied for implementation of the circular economy concept.

Major strengths are thus visible satisfactory level of enthusiasm and eagerness to innovate. Therefore, the entrepreneurial culture is a strong motivator to invest in this region's further development. There are many good examples which can inspire the rest of a local community. It is especially important that the local self-government creates the environment for local activities, influencing the investments (and also investing on their own), stimulating the improvement of quality of life for their inhabitants (Drejerska & Braja, 2014).

One cannot forget about the extended scope of possibilities, which is provided by the world of academia. The support by the scientific specialists is priceless, and could serve to e.g. optimize many solutions, increase their efficiency, etc. The theoretical background, including international dimensions, is very important as well. By explaining and implementing such notions as circular economy or corporate social responsibility, scientific expertise can support local actions to reach much further. At present, we can observe cooperation of local stakeholders with for example Warsaw University of Life Sciences (Poland) or University of Vaasa (Finland).

Experience is always regarded as a potential strength. This region has already implemented many programs aiming to develop multifarious skills (entrepreneurial, technical, regulations knowledge, agriculture specialization, etc.) Once the municipality's inhabitants acquire useful skills (i.e. in marketing which at this moment was identified as not sufficient - a weakness), it will become more competitive and thus, more attractive to potential investors.

The case of Krzyżewo (a village of Sokoły municipality) is also worth presenting as a sort of a role model, since it is a one of a kind medical complex (a building used previously as a primary school). It provides

Table 2 - swot analysis of Sokoły municipality

Strenghts	**Weaknesses**
High level of motivation and enthusiasm, entrepreneurial culture	Not enough skills for marketing services - previous experience with milk-based products, not familiar with innovations
Cooperation with academia	Limited capabilities, need to be sufficient
Experience in arranging various trainings and related services for agricultural specialized organizations	Small-sized, about 6000 inhabitants
Krzyżewo case - experience	Long distances
Plans to implement biogas solutions for heat and electricity	Language barriers
Potential for further development - agriculture, tourism; agritourism	Podlaskie voivodship - lowest level of investment attractiveness in Poland

Opportunities	**Threats**
Dynamics – Trans-rol case	Changes in agricultural sector - hard to follow
Growing skills coming from farming experience	Rapid structural changes
Collaboration with entrepreneurs and foundations	Coal-based Polish energy mix
Partnership with Finnish professional training organizations, e.g. Finnish entrepreneurship school - export oriented	Politically sensitive sector
Migration tendencies (urban-rural, cottages)	Competitors coming to Poland
Profitable energy prices	Inefficiency in decision making - different interest groups, financing structure

Source: own study.

healthcare services, with special units for mental treatment, nursing (for elderly people) and rehabilitation. It attracts patients from not only all over the country, but also from abroad. Such initiative could serve to promote the region, know-how exchange with other entrepreneurs operating in the municipality and hopefully, it will attract many partners by the fact of being socially responsible.

Furthermore, there is a idea to implement a biogas plant of 1.9MW capacity for both electricity and heating purposes. Such a smart, innovative and eco-friendly solution is a remarkable sign of the municipality representatives' approach towards transformation answering the trends of sustainable development and circular economy.

One biggest, overall weakness is a small size of this municipality which is rural/agriculture oriented, not so familiar with innovations (except from agriculture and food production, especially dairy production) or marketing services. Hence, its capabilities are in need for some optimization. Typical barriers coming from geographical placement are both long distances and possible languages difficulties. Nevertheless, the geographical barriers could be rather easily overcome by strengthened collaboration with foreign investors (e.g. Finnish ones, some of which were already presented to local authorities as a result of networking with academia), which are providing innovative technical and training support. In case of distances on a national level, thanks to a new highway, the placement of Sokoły municipality became very attractive.

There are various external opportunities for this territory. Dynamic development of agriculture can assure some potential demand. The case of Trans-rol can be presented here. The company is a distributor of high-quality fertilizers and other production factors for plant and animal production. Owners of the company are actively engaged in different activities for the local society.

Farms operating in the area investigated are highly specialized, mainly in milk production. Experience acquired by milk-based production enhances the use of top level of farming skills. By consequence, it can serve to promote this region abroad. In case of collaboration with Finnish side, many products or even some know-how can be launched and transferred in both directions, as milk production is also important in this Scandinavian country.

What's more, in case of financing possibilities, Finnish foundations are often eager to promote smart and courageous projects. In Finland, there are many innovation-oriented companies that seek for internationalization and thus can not only financially support such initiatives. Only in Ostrobothnia there are about 10 technology companies that could fit to this kind of solution. Examples of such are *Ecohel* or *Recomill*, which have already very strong connections with the University of Vaasa. Their operational focus is aimed to produce sustainable energy from industrial and residential waste, including typical agricultural by-products. Therefore, a regional smart specialization has a huge potential to be introduced. Finland has more to offer, as there are multiple professional training organizations, which could help e.g. by providing managerial support, marketing solutions, etc. Good example of such initiatives is Finnish Entrepreneurship School, which is known to be strongly export-oriented.

Another important aspect is a good, affordable electricity price in Poland. There are much more attractive than Finnish ones, estimated about 12 €cents/kWh for 2019. This market specification together with an impression of being strong in manufacturing (which still expresses huge potential) generates a big interest of Finnish companies to invest in these kind of activities.

Another potential opportunity is a phenomenon described as reverse migration (Day *et al.*, 1987). Nowadays, we can observe rural-urban migration tendencies. However, the society is getting older. This process creates an opportunity for the Sokoły municipality to attract mainly older part of the society to move to countryside in search for peaceful, environmentally friendly and stable life. Moreover, there is a growing number of strictly urban-connected diseases, e.g. allergies, respiratory diseases. This can convince people to move to the areas, where the air is less polluted. In other words, maintenance and improvement of quality of life opportunities can result in development opportunities as far as rural areas are able to innovate their productive offer (Schimmenti *et al.*, 2017). If the municipality would continue to develop itself, it could attract people to build e.g. cottages or summer houses there.

Moreover, there are plans to introduce a special economic zone in this municipality, which should be regarded as a huge development opportunity.

There are some threats as well. First, the most obvious but yet hard to overcome, are the rapid changes in the agricultural sector, especially the structural ones. They include decrease in farm's number with increase of their average area. More and more specialized agricultural production requires high technology solutions at the same time reducing demand for labour force. As a result lack of job opportunities determines outflow of youth from the region. Moreover, agriculture is not perceived as a very interesting option for professional career (Drejerska, 2018). Altogether it can lead to depopulation resulting then in worse economic performance of the region.

In case of green/renewable energy implementation in Poland, there is still a huge regulatory obstacle. Polish energy mix is based on coal and it will remain the leading energy source for at least a decade. Fortunately, there are many international regulations which push the signing members to follow the green rules. Thanks to UN COP21 Paris Agreement (Bulkeley, 2015) followed by the COP24 Conference in Katowice, and European Commission regulations, EU and Poland will reduce the CO_2 emissions and involve more renewable energy sources in their energy mix.

In the situation of many different interest groups being involved, there is often a possibility to have decision-making difficulties. In case of financing, every investor wants to have the highest possible return, but also the fair share. However, many suitable solutions for such cases already exist in Polish and European labor law.

Another potential threat could be a growing number of competitors coming to Poland. It is caused by constant economic growth of Poland which makes this country attractive to invest. It is a typical case of crisis of wealth.

Further actions need to be performed. First and foremost, the business model has to elaborated. As noticed before, numerous feasibility studies are necessary to push municipality development forward. There is a need to determine such data as size of a facility, the cost of raw material, including delivery and energy price, while producing heat, steam and electricity.

Moreover, flexibility level needs to be put at a highest possible at a given moment. During a consultation process, the idea of introducing the network of businesses appeared. This could show the potential to develop the whole region in a long term. In the form of orientation or simulation, it could help to adjust the necessary volumes and therefore, determine the whole business strategy.

Another important aspect inevitably necessary is the level of socioecological acceptance. The studies may be conducted to demonstrate the key issues among the local society. As a source of reference, the thinking according the TAM (Technology Acceptance Model) (Davis, 1989) could be used.

3.2. *From waste to resources: stimulating the secondary raw materials market and reusing water in the Sokoły municipality*

In a circular economy, materials that can be recycled are brought back into the economy as a new raw material, which increases the security of supply. These "recyclable materials" can be sold or sent, as well as primary raw materials from traditional natural resources. At present, secondary raw materials are still only a small part of production materials used in the economy. Waste management practices at the local level have a direct impact on the quantity and quality of these materials and, therefore, measures to improve these practices are essential.

The system of collection and collection of municipal waste in municipalities results from the amendment of the Act of 13 September 1996 on maintaining cleanliness and order in municipalities, which entered into force on 1 January 2012. In the new system introduced by the Act, municipalities were obliged to organize a system for collecting municipal waste from property owners where residents live, with the possibility of extending this system to other properties on which municipal waste is generated. The essence of the system was the taking over by the municipalities of the obligations of property owners in the field of municipal waste management in exchange for the payment made. Taking over of these

duties by the municipality is obligatory in relation to the real estate on which the residents live (it takes place by virtue of the Act), optional in relation to real properties where municipal waste activities are carried out (may take place on the basis of a municipal council resolution). The fee depends on the number of inhabitants, the area of the property, the amount of water consumed, or it can be a flat rate for a household, but the rate of the fee for separately collected waste should be lower. In exchange for the payment, the municipality provides collection of municipal waste by the entity selected in the course of the tender procedure and their proper development. After the entry into force of the law on the maintenance of cleanliness and order in municipalities, there was a decrease in a production of mixed waste in entire Poland (Gołębiewska, 2017).

The municipal waste management system in the Municipality of Sokoły is based on the assumptions of the Waste Management Plan for the Podlasie Voivodship for the years 2016-2022. According to this plan, the municipality was qualified for the region in which there are two regional waste treatment installations, i.e. Waste Processing and Neutralization Plants in Czerwony Bór and in Czartoria. Mixed municipal waste from the entire Sokoły municipality is transferred to the first of these two plants. The collection of waste from the investigated municipality is carried out by a specialized enterprise selected on the basis of an unlimited tender. The company is responsible for the collection of mixed municipal waste, segregated municipal waste, large-scale waste collection, expired drugs, used batteries and accumulators.

The entity collecting municipal waste from the property owners (all mixed municipal waste and residues from sorting, mechanical and biological treatment of municipal waste), transfers it to the installation located in the waste processing and disposal plant. In 2018, a total of 973 tonnes of mixed municipal waste were collected and transferred to a waste treatment facility and processed (mechanical-biological treatment processing). It should be noted that the total amount of collected waste, including waste collected selectively, was growing in the period 2018-2014. Municipal waste was received mainly as mixed. According to the most recent data, the studied municipality reached the following levels in 2018 (Analysis…, 2019):

a) the ratio of recycling, preparation for re-use and recovery of paper, plastic metals and glass - 40.44% (a the minimum level of 30%),
b) the ratio of mass of biodegradable municipal waste transferred to storage - 42.83% (at the maximum level of 40%),
c) the level of recycling, preparation for use and recovery by other methods of construction and demolition waste - 100% (with the minimum level of 50%).

This summary shows that the current waste management system in the Sokoły municipality does not function ideally as it did not allowed to achieve all required ratios. However, it should be noticed that they were achieved for previous years. In such a situation, the priority task of the Sokoły municipality for the coming years is to increase the awareness of inhabitants in the proper management of municipal waste in order to reduce the amount of municipal waste generated and to sort them efficiently to achieve the required levels of recovery and recycling, thus reducing the costs of their management.

Investigated municipality is not only an interesting example of solid waste management but also implements good solutions devoted to liquid waste management. They are significant as in some parts of the EU, water scarcity has become a major problem in recent decades and has had a destructive effect on the environment and economy. In addition to measures for efficient water use, re-use of treated wastewater in safe and cost-effective conditions is a valuable but rarely used way to increase water resources and relieve over-exploited water resources in the EU. The reuse of water in agriculture also contributes to the recycling of nutrients that replace solid fertilizers.

The Sokoły municipality, like majority of others in the Podlaskie region, is a typically agricultural where predominantly dispersed farm buildings predominate. These municipalities are struggling to find the solution to the problem of wastewater management. Construction and operation of a sanitary sewage system is too expensive investment for communes and inhabitants of villages. The solution that has been implemented in the municipality in the field of wastewater management is the construction of home sewage treatment plants based on a plant filter and a denitrification pond. This process began already at the beginning of the 21st century. In 2004, 11 pilot sewage treatment plants were completed. Further implementation of the construction of this type of treatment plant in the municipality of Sokoły is carried out by the municipal self-government. The simplicity of construction of wastewater treatment plants makes farmers perform them on their own, in an economic manner, with the supervision of an employee of the Sokoły Municipal Office. No construction permit is required for it, in fact only a notification should be given to the district office. In the Podlaskie region, the Sokoły was the first to address this issue with wastewater management solutions. About 25 municipalities have already benefited from the Sokoły's experience by building about 640 wastewater treatment plants.

The implementation of home sewage treatment plants based on a plant filter and a denitrification pond is a cheap and effective way to treat wastewater from rural households. The advantages of this type of treatment plant are not only the simplicity and low construction costs, but also the ease and negligible operating costs and, above all, the positive impact on

the natural environment. These purifiers also increase the aesthetic value of the plot on which they are built. What is worth emphasizing, the Sokoły Municipal Council supports construction of household sewage treatment plants by granting subsidies of up to 50% of documented gross costs, but not more than PLN 1,000 (which is about 230 €).

Conclusions

The study was aimed to recognize existing local solutions of circular economy as well as to identify possible ways for its development. It was completed with a special regard to the waste management issue, as this is one of the crucial areas of circular economy for which local authorities are responsible for. A mixed methodology analysis performed emphasizes a favorable environment for an enhanced development of this concept, which is also in line with a fact that innovative technology solutions need to be decentralized.

A circular economy at the local level requires appropriate technical and educational infrastructure as well as innovative communication systems with the public. It also means that a new approach to the issue of municipal waste in rural areas is critical. Waste, according to the assumptions of circular economy, ceases to be unnecessary objects and becomes potential raw materials for production of various goods of market value. Implementation of the circular economy principles requires interaction and cooperation between local self-government, the business sector and an effective education system.

As concluded during the SWOT analysis, the local authorities of the investigated area have expressed a satisfactory extent of a willingness to implement innovative waste treatment solutions. Some supportive policies have already been implemented to foster the idea of sustainable society and further projected initiatives, such as biogas plant of 1,9MW capacity, are aimed at increasing development of the circular economy concept within the community.

Entrepreneurial culture of local actors and an attractive localization of the Sokoly municipality have resulted in established cooperation with international partners, both from academia and business side. Experience from Finland, which is a leading country in the areas of innovations and sustainability, can boost the process of introducing waste-to-energy projects. In addition to the municipality waste solutions, industrial waste can be processed in a very effective way. The Podlaskie region is known to be a leading producer of animal products, such as milk or meat in Poland. The animal by-products can be recyclable into energy (vide *Recomill*) and such investments have been suggested by the Finnish side and are now

considered by the local government. However, in order to develop a clear and comprehensive investment strategy, numerous more advanced feasibility studies need to be performed.

It is necessary to continue and intensify information and education activities in the area of increasing public awareness of waste prevention, their removal under communal waste collection and collection systems, and proper management of municipal waste (including food waste and other biodegradable waste). This sector is strongly influenced by the public regulations, therefore, more focused cooperation between different stakeholders is recommended.

References

Aaltonen, J., Rinne, J. & Tuikkala, I. (2006). A Multidisciplinary Framework for Concept Evolution: A Research Tool for Business Models. In M. Maula, M. Hannula, M. Seppfä & J. Tommila (Eds.), *ICEB + eBRF 2006 Frontiers of e-Business Research 2006* (pp. 526-532). Tampere University of Technology and University of Tampere.

Agovino, M., Cerciello, M. & Musella G. (2019). The good and the bad: Identifying homogeneous groups of municipalities in terms of separate waste collection determinants in Italy. *Ecological Indicators*, *98*, 297-309. doi: 10.1016/j.ecolind.2018.11.003.

Analysis of the state of municipal waste management in the Sokoły municipality in 2018. -- http://sokoly.pl/images/2019/nieczystosci2019/analiza.pdf (accessed 03.05.2019).

Bocken, N.M.P., de Pauw, I., Bakker, C. & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308-320. doi: 10.1080/21681015.2016.1172124.

Borrello, M., Caracciolo, F., Lombardi, A., Pascucci, S. & Cembalo, L. (2017). Consumers' Perspective on Circular Economy Strategy for Reducing Food Waste. *Sustainability*, *9*(1), 141. doi: 10.3390/su9010141.

Bulkeley, H. (2015). Can cities realise their climate potential? Reflections on COP21 Paris and beyond. *Local Environment*, *20*(11), 1405-1409. doi: 10.1080/13549839.2015.1108715.

Chermack, T.J. & Kasshanna B.K. (2007). The Use of and Misuse of SWOT analysis and implications for HRD professionals. *Human Resource Development International*, *10*(4), 383-399. doi: 10.1080/13678860701718760.

Davis, F.D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319-339. doi: 10.2307/249008

Day, R.H., Dasgupta, S., Datta, S.K. & Nugent, J.B. (1987). Instability in rural-urban migration. *The Economic Journal*, *97*(388), 940-950.

Drejerska, N. (2018). *Przemiany sektorowej struktury zatrudnienia ludności wiejskiej*. Warsaw, Publishing House Wydawnictwo SGGW.

Drejerska, N. & Braja, M. (2014). Local self-governments as actors in local development - a perspective of inhabitants of the Warsaw suburban area. In L. Smutka (Ed.), *Agrarian perspectives XXIII. The community-led rural development. Proceedings of the 23th international scientific conference, September 16, 2014*. Prague, Czech Republic (pp. 271-277).

EC (2014). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Towards a circular economy: A zero waste programme for Europe. (COM(2014) 398 final).

EC (2015). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Closing the loop - An EU action plan for the Circular Economy. COM(2015) 614 final

EC (2017). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions The role of waste-to-energy in the circular economy. (COM(2017) 34 final).

EC (2018). Frequently asked questions on Natura 2000. -- https://ec.europa.eu/environment/nature/natura2000/faq_en.htm, retrieved 18 May 2018.

EMAF (2012). Towards the Circular Economy Vol. 1: an economic and business rationale for an accelerated transition. Ellen MacArthur Foundation, -- www.ellenmacarthurfoundation.org/publications/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an-accelerated-transition (accessed 03.05.2019)

Gołębiewska B. (2017). Changes in waste management in the EU countries. In A. Auzina (Ed.), *Integrated and sustainable regional development: marketing and sustainable consumption. Proceedings of the International Scientific Conference,* 27-28 April 2017, Jelgava, Latvia (pp. 87-94).

Kasanen, E. (1986), Capital Budgeting and the Control of Business Unit Growth (DBA Thesis at the Harvard Business School, reprinted ln the Publications of the Turku School of Economics and Business Administration A-4).

Kasanen, E., Lukka, K. & Siitonen, A. (1991). Constructive approach in business studies. *Finnish Journal of Business Economics, XL.*

Kasanen, E., Lukka, K. & Siitonen, A. (1993). The Constructive Approach in Management Accounting Research. *Journal of Management Accounting Research*, *5*, 243-265.

Kirchherr, J., Reike, D. & Hekkert M., (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221-232. doi: 10.1016/j.resconrec.2017.09.005.

Korhonen, J., Honkasalo, A. & Seppälä, J. (2018a). Circular economy: the concept and its limitations. *Ecological economics*, *143*, 37-46. doi: 10.1016/j.ecolecon.2017.06.041.

Korhonen, J., Nuur, C., Feldmann, A. & Birkie, S.E. (2018b). Circular economy as an essentially contested concept. *Journal of Cleaner Production*, *175*, 544-552. doi: 10.1016/j.jclepro.2017.12.111.

Lieder, M. & Rashid, A. (2016). Towards circular economy implementation: a comprehensive review in context of manufacturing industry. *Journal of Cleaner Production*, *115*, 36-51. doi: 10.1016/j.jclepro.2015.12.042.

Lokesh, K., Ladu, L. & Summerton, L. (2018). Bridging the Gaps for a 'Circular' Bioeconomy: Selection Criteria, Bio-Based Value Chain and Stakeholder Mapping. *Sustainability*, *10*(6), 1695. doi: 10.3390/su10061695.

Menon, A. *et al*. (1999). Antecedents and Consequences of Marketing Strategy Making. *Journal of Marketing*. American Marketing Association, *63*(2), 18-40. doi: 10.2307/1251943.

Niiniluoto, I. (1984). Criteria of Science (in Finnish, translation of the title by EK, KL and AS), in the work (Niiniluoto): Science, Philosophy arvd World-View (in Finnish, translation of the tide by EK, KL and AS) (Otava, 1984).

Oyegoke, A. (2011). The constructive research approach in project management research. *International Journal of Managing Projects in Business*, *4*(4), 573-595. doi: 10.1108/17538371111164029.

Podlaskie (2016). Plan gospodarki odpadami województwa podlaskiego na lata 2016-2022.

Proctor, R.A. (1992). Structured and creative approaches to strategy formulation. *Management Research News*, *15*(1), 13-19. doi: 10.1108/eb028190.

Schimmenti, E., Collura, G.B., Migliore, G., Di Franco, C.P., Asciuto, A. & Borsellino, V. (2017). Cooperation in Rural Areas as a Local System Development Opportunity. *American Journal of Applied Sciences*, *14*, 1178-1185. doi: 10.3844/ajassp.2017.1178.1185.

Singh, J. & Ordoñez, I. (2016). Resource recovery from post-consumer waste: Important lessons for the upcoming circular economy. *Journal of Cleaner Production*, *134*(SI), 342-353. doi: 10.1016/j.jclepro.2015.12.020.

Statistical Atlas of Podlaskie Voivodship 2018. Statistical Office in Białystok - Podlaski Regional Research Centre, Białystok.

Statistical vademecum for local self-governments, -- https://stat.gov.pl/statystyka-regionalna/statystyczne-vademecum.

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