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A SUSTAINABLE MODEL OF MUNICIPAL ECONOMY

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ABSTRACT: Sustainable development is a dynamic process based mainly on quantitative and qualitative changes in the economic, social and ecological spheres in accordance with the needs and preferences of the commune's inhabitants. Municipal management, however, creates favourable conditions for local development and constant improvement of the quality of life of residents. The aim of the study is to analyse municipal management from the perspective of sustainable development. The basic research method used in the study is indicator analysis. The indicators selected for development describe the concept of sustainable development in fundamental areas of the municipal economy, such as energy, water and sewage, waste, municipal housing, public transport and road infrastructure. The research was conducted in Poland in the Warmian-Masurian Voivodeship in 2020-2022. The subjects of the study are the 12 municipalities of the Olsztyn district. On the basis of the results obtained, it can be concluded that the best results in terms of creating a sustainable municipal economy are obtained by municipalities which have carried out the largest number of projects in this area, as well as those which have the largest share of forests and waters in the municipal area, e.g. Stawiguda, Dywity, Dobre Miasto, Gietrzwałd. The implementation of sustainable development in municipal management is determined by many economic, social, environmental, spatial and technological conditions. The research will enable local authorities and decision-makers to practically implement the concept of sustainable development in the municipal economy and may also be used in the process of planning investments and local activities, taking into account the economic, ecological and social aspects. The research constitutes the basis for further research work related to the practical implementation and management of sustainable development in municipal management.

KEYWORDS: sustainable development, municipal economy, indicators

Introduction

Globally, several factors have made it imperative for economies to transition from a brown economy to a green economy as an important vehicle to achieve sustainable development (Akalibey et al., 2023). A brown economy, in this regard, refers to an economy that depends on all forms of environmentally destructive activities, such as the use of fossil fuels for production, generation of energy, and transportation activities, among others. A green economy improves well-being, ensures social equity, and reduces environmental risks significantly (Green Economy Coalition, 2020).

One of the key areas of local government activity is municipal management, which is the basic infrastructural foundation affecting the quality of life of the local community as well as enabling economic development, which in turn affects the competitiveness of the municipality as well as the entire region (Miszczuk et al., 2007; Bałdyga, 2008; Kulesza, 2012; Kołodziejczyk, 2014). Adequate municipal infrastructure and a high standard of municipal services have a significant impact on investors, who attach great importance to the quality and efficiency of the services provided, which directly affects the attractiveness of a municipality as a place to settle while also shaping the investment climate for businesses (Markowski, 2008; Grzymała, 2011; Kozłowski, 2015). The level of municipal services is particularly important in regions with a dominance of industry and tourism (Ratajczak, 2000; Bański, 2014).

However, local communities are heterogeneous in their sustainability needs and priorities, which requires the global goals and targets to be tailored and localised to align with local priorities (Moallemi et al., 2020). Raworth proposes to move from today's industrial model built on the logic of "take-make-use-loose" into a regenerative one. She argues for circular design principles where products and services, infrastructures, and businesses aim to have zero environmental impact and even to give back more than they take (Raworth, 2017).

By joining the structures of the European Union, Poland undertook to align its laws with Community regulations. This also means striving to align normative regulations in the field of municipal management with European Union directives and standards. Of particular importance are the directives translated into Polish legislation related to environmental protection (Act, 2001), energy policy (Act, 1997) and water management (Act, 2023) (Bukowski, 2009). Which, in turn, has implications for the development of municipal infrastructure in these areas. Environmental, social, and technical aspects should now be considered equivalently when planning the development of municipal economies in cities and municipalities. Thus, the guiding idea for the development of the municipal economy should be a model of sustainable development.

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An overview of the literature

Taking care of future generations, assumptions for the so-called sustainable development model have been developed in the European Commission, to the realisation of which we should all contribute by pursuing a long-term development policy in ecological, social, and economic aspects (Brundtland, 1991; Daly, 1991; Pearce et al., 1990).

In economics, it is accepted that sustainable development is the idea of a new concept of permanent civilisational development. It is also often referred to as "sustainable development", "self-sustaining development", or simply "eco-development". Defining the term eco-development means subordinating the needs and aspirations of society and the state to the opportunities provided by the environment at our disposal (Urbaniak, 2007). The idea comprehensively addresses the problem of the long-term ability of the modern economy to develop while meeting the criterion of intergenerational equity. The concept of sustainable development has become one of the basic constitutional principles of the system of the Polish state[1].

Sustainable development is a dynamic process based mainly on quantitative and qualitative changes in the social, economic, and ecological spheres (WCED, 1987; Sarang et al., 2008). Thus, the concept of sustainable development should be treated as a universal development strategy whose mission is to permanently improve the quality of life of present and future generations through the proper dynamic shaping of the proportion between different types of capital – economic, human, and natural (Piontek, 2001; Borys, 2005; Kryk, 2012). In economics, it is assumed that sustainable development is the idea of a new concept for the continuous development of civilisation. A common feature of the definition of sustainable development is that it seeks to satisfy human needs, taking into account social and environmental conditions (Gerwin, 2008; Pawłowski, 2008; Burchard-Dziubińska et al., 2014).

Assessing the sustainability of urban systems is becoming increasingly important, in parallel with the growing need to make communities more sustainable (Marvuglia et al., 2020). At the same time, the current shift towards sustainable development practices requires international engagement with local authorities to engage local thinking. This requires complementary action from governments, civil society, science, and business in each country (Sachs et al., 2019). The role of cities and communities in achieving the Sustainable Development Goals (SDGs) is reaffirmed by SDG Goal 11: 'Make cities and human settle-

[1] According to Article 5 of the Polish Constitution: "The Republic of Poland shall safeguard the independence and inviolability of its territory, ensure the freedom and rights of man and citizen and the security of citizens, guard the national heritage and ensure the protection of the environment, guided by the principle of sustainable development".

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ments inclusive, safe, resilient and sustainable'. If achieved, this goal can set the stage for other Sustainable Development Goals (United Nations, 2015).

An essential element of sustainable development management is the monitoring of performance in key areas described by indicators (Eurostat, 2015). To monitor sustainable development, the European Commission has developed a detailed set of indicators, also considering their political significance for the European Union and statistical quality. Depending on the type and scope of monitoring, the review of indicators takes place once a year (Komisja Europejska, 2021). On the one hand, the indicators are carriers of the concept of development, and on the other hand, they highlight the opportunities that arise from the actions taken, allowing a reliable assessment of the existing state, as well as the forecast of economic, social, and environmental effects.

To contribute to the overall achievement of goals of sustainable development at national and global scales, local communities need to focus on a subset of locally relevant goals and understand potential future pathways for key drivers of local sustainability (Szetey et al., 2021).

The scope and type of activities of local government in creating sustainable development are largely determined by the scope of implementation of their own tasks and mainly concern the areas of municipal management. The formal activity of municipalities in the field of their own tasks is defined in the laws on municipal, district, and provincial government (Act, 1990). One of the important measures of decentralisation of public spending is the ratio of local government spending to state budget spending; it directly reflects the extent of decentralisation of public spending (tasks). This ratio is steadily increasing. For example, in 1990, it was 18.5%; in 1999, it had already reached 49.5%; in 2014, it was 52.1%. In 2021, it was 61% (Ministerstwo Finansów, 2021). The upward trend means that local government units are carrying out an increasing share of public tasks in Poland while incurring more and more current and investment expenses. The upward trend means that local government units are carrying out an increasing share of public tasks in Poland while incurring more and more current and investment expenses. Therefore, the self-government's own tasks implemented should be characterised by a well-understood social interest, considering social and environmental aspects in addition to economic aspects (Biniecki & Szczupak, 2001).

Synonymous with sustainable development in local governments is the implementation of own tasks based on municipal infrastructure, adapted to the needs and preferences of the residents of the municipality, while creating favourable conditions for investment and business in the area (Adamska, 2008; Kozłowski, 2012). It is the municipal economy that is now the foundation for creating sustainable development in a given municipality, as it includes socio-economically important areas such as energy, waste management, water management, sewerage, local roads, municipal housing, and urban transportation. According to Statutory Definition (Act, 1996), municipal management includes

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tasks of a public utility nature, the purpose of which is to meet the collective needs of the population on an ongoing and uninterrupted basis through the provision of generally available services. And is currently treated as a branch of the national economy, the purpose of which is to meet the material and subsistence needs of the population in various economic sectors. The basic areas of the municipal economy are shown in Figure 1.

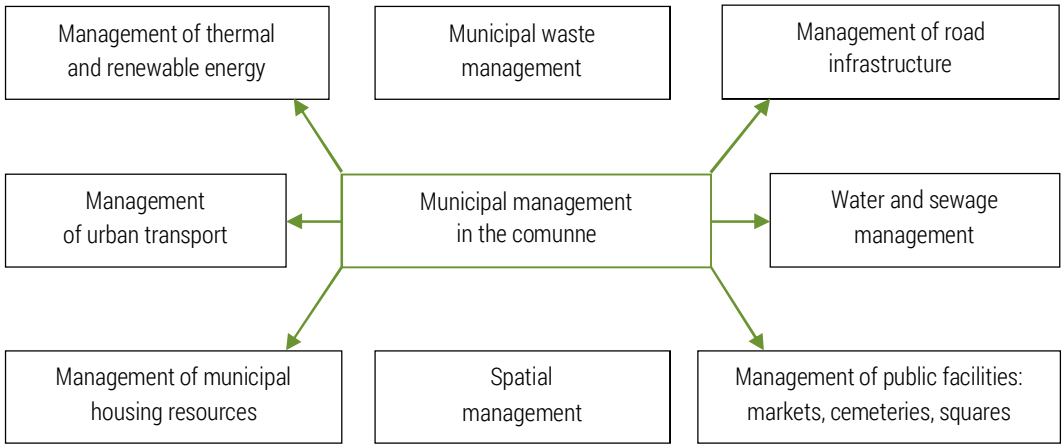

Figure 1. Basic areas of municipal management

Source: authors' work based on Karst (1986); Aziewicz (1998); Grzymała (2011); Kozłowski (2015).

When joining the structures of the European Union, Poland undertook to adapt its legal regulations to those of the Community in the field of municipal management. The EU acquis in this area defines many safety standards, as well as efficiency standards. Therefore, in the aspect of adjusting the municipal economy to EU standards, it is important that the policy of local authorities within individual areas is based on the standards developed by EU member states. The EU policy on improving the municipal economy is characterised by a framework of sustainable goals Figure 2.

The specificity of municipal management stems from several features of an economic and social nature, where social and environmental interests should be integrated with the economic efficiency of ventures and municipal activities. Implementation of the idea of sustainable development in the municipal economy aims to achieve a few measurable benefits, which should be described by indicators, showing us the benefits, as well as losses and risks associated with the implementation of the idea of sustainable development. Diagnosing losses or risks is the basis for eliminating them altogether or at least improving the situation. According to Klamut (1994), it is possible to speak of the existence of certain relationships that can either favour development or limit it. These relation-

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ships are an important driving force for development, as they create the phenomenon of synergy.

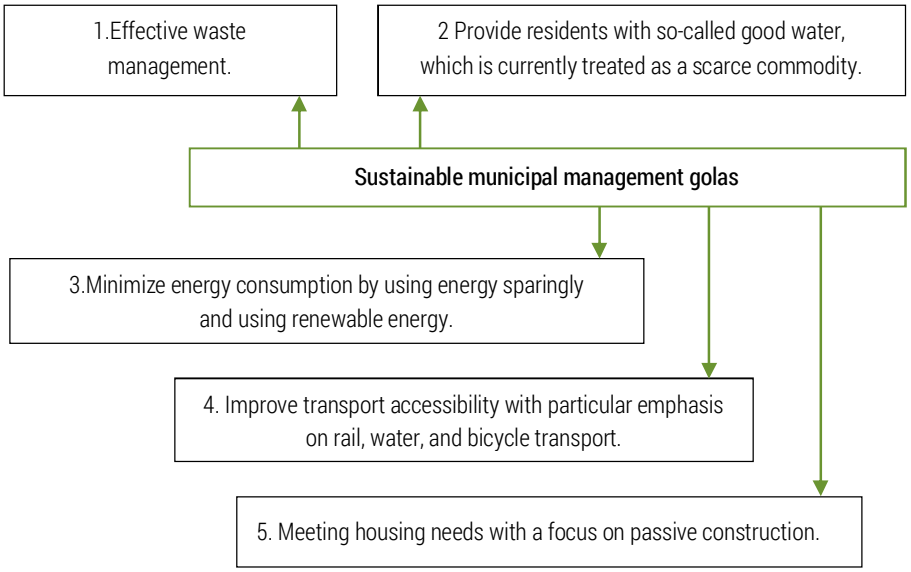

Figure 2. Sustainable municipal management goals

Source: authors' work based on Sachs (2012) and Sachs et al. (2019).

The strategic principles relating to the management of resources for sustainable municipal management are:

1. Reduction and minimisation of consumption of energy, water, gas, raw materials, and materials used in municipal management.
2. Reuse: energy (e.g., renewable energy, recuperators); water (e.g., closed industrial water circuits, rainwater); and waste (e.g., glass packaging).
3. Reintroduction of secondary materials and raw materials, including organic.

We need to move towards a more virtuous model for the circular economy, based on the principle that in nature, nothing is "waste" and everything can become a "resource", which is proposed to operationalise sustainable development principles. The circular economy can be defined as "restructuring the industrial systems to support ecosystems through the adoption of methods to maximise the efficient use of resources by recycling and minimising emissions and waste". It refers to how resource flows can be closed (Girard & Nocca, 2019). The principles of managing capital and economic resources are formulated in various forms of balanced and sustainable development. They are presented, inter alia, in (1) with reference to traditional models of growth (development), both in their extensive and intensive form; (2) as principles based on the idea of equilibrium between orders and preserving certain relationships of natural cap-

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ital to other capitals; (3) in the form of in-depth principles of rational management; (4) in the form of principles combining the physical and economical approach, and (5) in the form of principles based solely on the physic-thermodynamic approach to the idea of balanced and sustainable development (Becla & Czaja, 2022).

Within the framework of sustainable municipal energy management, municipalities should take initiatives and measures:

- to increase the use of renewable energy for individual households, businesses and public buildings,
- increasing energy efficiency in plans for the supply of heat, electricity, and gaseous fuels-thermal modernisation of buildings,
- including in the municipality's development strategy areas for the location of investments in renewable energy sources (wind, solar, water, geothermal, biogas, biomass energy),
- inserting energy clauses in contracts for the use of renewable energy,
- promoting cooperation between energy companies and institutions, for joint ventures,
- counteracting emissions of air pollutants from municipal energy facilities and equipment, and from homes,
- creating the SMART GRID model,
- promoted "civic energy".

Within the framework of sustainable water management, municipalities should take initiatives and actions on:

- managing water in a catchment system (creating an agreement or association of municipalities for this purpose),
- increasing water retention (e.g., by draining rainwater into water reservoirs),
- striving for a water supply system for all villages in the municipality, and modernising water infrastructure to ensure proper water treatment process,
- reducing water consumption in public use facilities and metering water consumption-automation, intelligent measuring, and metering devices,
- prevention of floodplain development.

Within the framework of sustainable management of sewage infrastructure, municipalities should take initiatives and measures:

- through the development of sewage infrastructure and control to counteract septic tank leaks,
- pro-ecological management of sewage sludge (e.g., for biogas production),
- introducing separating toilets in public spaces (using grey wastewater or minimised amounts of water for flushing),
- protection of surface water and groundwater from industrial pollution and agrochemicals,
- popularising the use of closed water circuits in industrial installations (e.g., in mechanical-biological waste treatment stations, industrial plants),

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- taking environmental aspects into account in tenders in the water and sewage industry (green public procurement).

As part of sustainable municipal waste management, municipalities should take initiatives and actions:

- encompassing all property owners in the municipality in the municipal waste management system,
- creating conditions for carrying out cleanliness and orderliness work in the municipality or ensuring that this work is carried out by creating appropriate organisational units,
- implementation of selective collection of municipal waste,
- ensuring the construction, maintenance, and operation of own or joint with other municipalities: regional municipal waste processing facilities,
- ensuring the achievement of appropriate levels of recycling, preparation for reuse and recovery by other methods and reduction of the mass of biodegradable municipal waste sent to landfills.

Within the framework of sustainable management of municipal housing, municipalities should take initiatives and actions:

- creating space for the location of municipal construction (land, accessibility),
- issuing permits for individual construction considering the so-called compact development,
- creation and promotion of passive construction in the municipal area – reducing CO_2 emissions, energy consumption and waste,
- creation and promotion in the municipal area of construction of houses with materials and raw materials that generate low environmental costs.

Within the framework of sustainable municipal management of urban transportation, municipalities should take initiatives and actions:

- based on modernising the public transportation fleet – by increasing the share of biofuels consumed by vehicles and replacing the vehicle fleet from classic to electric,
- expanding rail transportation,
- expanding bicycle paths,
- incorporating environmental considerations into public procurement procedures for transportation and communications – "green tenders",
- optimisation of public transportation logistics,
- optimisation of transport accessibility of municipalities through the development of road networks.

Analysing the literature, there is a lack of studies relating to the analysis and evaluation of the municipal economy as an important local subsystem influencing socio-economic development. However, attempts have been made to analyse the individual elements that make up the municipal economy (Graczyk, 2019).

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Research methods

The aim of the article is to formulate and empirically verify a model of sustainable development of the municipal economy in municipalities based on selected indicators. Developing indicators is always a two-way process. The development of indicators cannot be a purely technical or scientific process; rather, it should be an open process of communication with the local community. Indicators suitable for this purpose must be simple and focused (a) the number of indicators must be limited and the way in which they are calculated transparently; (b) indicators should indicate important directions for sustainable development (Valentin & Spangenberg, 2020). The main systematic issues currently under discussion at a local level are: (1) What interests should be taken into account when developing indicators? (2) How can broad participation be managed? (3) Which indicators are good and which are bad? (4) What set of sustainability indicators should be used to make decisions? Against this background, a model of indicators was defined to assess the development of the municipal economy in the social, ecological and economic aspects.

Figure 3. Olsztyn District divided into municipalities

Source: www.mapa-polski.net.pl.

The subjects of the study are the municipalities of the Olsztyn poviat, i.e. Stawiguda, Purda, Olsztynek, Gietrzwałd, Jonkowo, Świątki, Dobre Miasto, Dywity, Jeziorany, Kolno, Biskupiec, Barczewo (Figure 3). The Olsztyn poviat is made

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up of 12 municipalities, 4 of which are urban-rural and 8 rural. The largest municipality in terms of area is Olsztynek, 372 km^2. In terms of the population of Biskupiec, there are 19,157 inhabitants. The characteristics of the selected variables of the municipalities are presented in Table 1.

Table 1. Surface area and population of Olsztyn County municipalities as of 31.12.2022

Municipalities	Area [km^2]	Districtarea [%]	Population pcs	Percentage of district population %	Population density Pcs/km^2
Olsztyn District	2 837	100,00	123 049	100,00	43,4
Barczewo	320	11,28	17 465	14,19	54,6
Biskupiec	290	10,23	19 157	15,57	66,1
Dobre Miasto	259	9,12	16 161	13,13	62,4
Dywity	161	5,68	11 097	9,02	68,9
Gietrzwałd	172	6,07	6 485	5,27	37,7
Jeziorany	212	7,4	7 952	6,46	37,7
Jonkowo	169	5,94	7 090	5,76	42,0
Kolno	179	6,29	3 292	2,68	18,4
Olsztynek	372	13,09	14 007	11,38	37,7
Purda	317	11,21	8 507	6,91	26,8
Stawiguda	223	7,85	7 656	6,22	34,3
Świątki	164	5,78	4 180	3,40	25,5

Source: authors' work based on Statistics Poland (2022).

A large share of agricultural land means that the district has good conditions for the development of agriculture and the agri-food industry. The district is characterised by a significant share of forest land, 39% of the total area, and numerous water reservoirs (155 lakes). Surface waters constitute 4.6% of the district's area (Table 2).

The highest investment outlays in municipal management in 2012-2021 were recorded in Dywity – PLN 94.3 million, Biskupiec – PLN 101.5 million, Stawiguda – PLN 98.5 million. The smallest funds for municipal investments in the Kolno – PLN 8.2 million and Świątki – PLN 14.1 million (Table 10). Analysing investments through the prism of the functional criterion, municipalities invested the most money in the development of transport infrastructure – PLN 382.4 million, and environmental protection – PLN 131.5 million (Table 3).

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Table 2. Land use structure in Olsztyn County [%]

Municipality	Surface Municipality [ha]	Share			
		Agricultural land	Forests	Water	Other
Barczewo	32001	49,36	34,34	4,82	11,48
Biskupiec	29041	56,94	26,93	5,79	10,34
Dobre Miasto	25869	49,60	38,71	1,60	10,09
Dywity	16116	58,62	27,84	2,07	11,47
Gietrzwałd	17233	36,88	51,64	4,08	7,40
Jeziorany	21149	66,98	22,67	1,81	8,54
Jonkowo	16869	48,88	39,12	1,08	10,92
Kolno	17859	60,44	26,68	4,72	8,16
Olsztynek	37151	34,47	53,78	3,80	7,95
Purda	31812	29,12	53,99	6,29	10,60
Stawiguda	22287	23,11	56,85	14,59	6,05
Świątki	16415	75,64	12,77	1,5	10,09
Total	283802	47,15	38,82	4,58	9,45

Source: authors' work based on Statistics Poland (2022).

Table 3. Investment expenditure of municipalities in municipal economy areas in 2012-2021

Municipality	Protection environment	Transport	Economy municipal	Housing	Total
Barczewo	17164466	27237929	13590666	4267432	62260493
Biskupiec	14563120	63420126	19251617	4242607	101477470
Dobre Miasto	5251587	53044075	2091098	3665880	64052640
Dywity	11845356	76820435	3352638	2325397	94343826
Gietrzwałd	19711073	22491631	2791967	2673993	47668664
Jeziorany	6497656	25437000	15751682	2807578	50493916
Jonkowo	983383	9834673	29044170	144580	40006806
Kolno	6336372	1027336	726413	106657	8196778
Olsztynek	13801076	17270570	21902088	5723612	58697346
Purda	13331717	6621293	6510672	2902255	29365937

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Municipality	Protection environment	Transport	Economy municipal	Housing	Total
Stawiguda	20209400	73679928	1546096	2983813	98419237
Świątki	1773822	5495898	3928181	2931343	14129244
Total	131469028	382380894	120487288	34775147	131469028

Source: authors' work based on Statistics Poland (2022).

The research was carried out in 2020-2022. The main research methods used in the study are critical analysis, indicator analysis, and statistical methods such as Ward's cluster method and class ranking. The research process was broken down into 3 stages. At the first stage, a model of sustainable municipal management was developed, along with the socio-economic indicators describing it. In the second stage, the tools used by the surveyed municipalities for sustainable municipal management were analysed. The third stage concerned the analysis of indicators describing sustainable municipal economy in a 4-year perspective, i.e., 2017-2021, along with the analysis of similarities occurring between the studied municipalities and the ranking of classes. The model of the municipal economy developed for the research needs of this study includes a description of the most important areas of the municipal economy by means of a set of indicators to assess sustainable development (Figure 4).

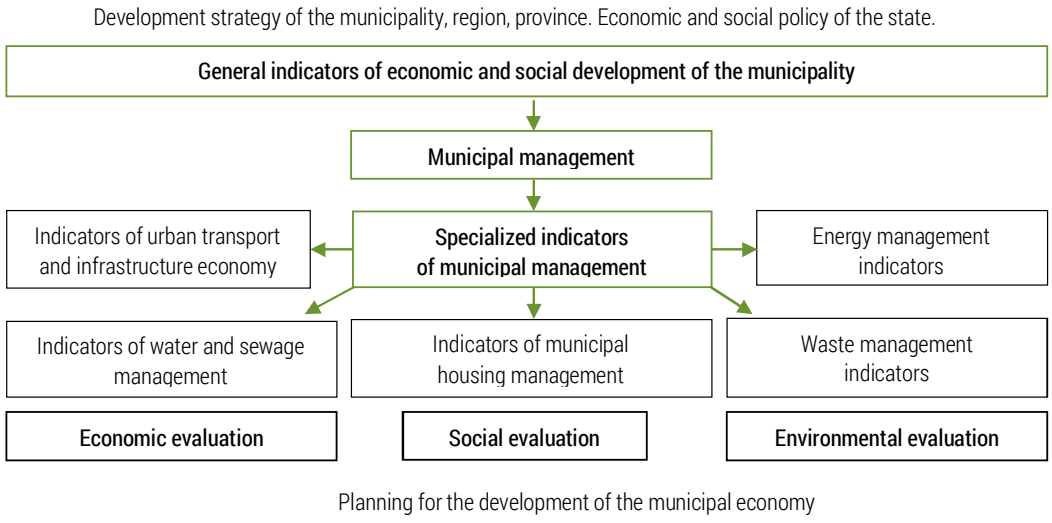

Figure 4. Indicative assessment model for municipal management

Source: authors' work based on Lueg and Radlach (2016).

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The model assumes that the development of the municipal economy in its various aspects depends largely on several conditions of nature:

- strategic (municipal strategy),
- economic-financial (financial resources possessed and obtainable),
- social (analysis of actual social needs and priorities),
- environmental (resulting from legal acts regarding environmental protection and the attitude of the local community to ecology).

The purpose of the model is to analyse and evaluate the effects achieved by municipalities in municipal management from the economic, social, and environmental perspectives, as well as to determine the cause-effect relationships between the analysed indicators. In the practice of local government management, the developed model makes it possible to develop and plan municipal management in individual areas based on the assumed effects expressed by indicators.

The most important external determinants include the socio-economic policy of the country and the development strategy of the municipality, region, and province. The most important element of the model is a set of indicators that allow analysis and evaluation of the economic, social, and environmental effects achieved through investments and actions taken. The indicators defined in the model are an information-diagnostic tool and can be selected by a given municipality depending on its needs, priorities, and socio-economic development goals (Table 4). Their change over time, juxtaposed with changes in other similar local governments, allows monitoring of development processes and programs implemented in each local government unit. The model module of sustainable development includes 246 indicators. To monitor the sustainable development of local governments understandably and transparently, the list was shortened to 73 indicators. The dominant 29 indicators are related to the environment, 26 are a group of indicators of social governance, and the group of indicators of economic governance includes 18 indicators (Borys, 2005). A detailed classification of sustainability indicators in the energy industry is presented by Graczyk (2017).

The approach to monitoring and evaluation must evolve according to the participants. Monitoring is a continuous evaluation that provides feedback on the programme or project in relation to the intended objectives. The way sustainability is measured should be in terms of efficiency and effectiveness within the system. A dynamic approach should take place in terms of systems thinking by integrating all the different systems that are in play. This is seen as an important tool to unpack these systems in order to implement the sustainable actions that emerge from them (Maijo, 2020).

Based on the measurement of the defined indicators, it is possible to determine which areas of municipal management contributed to the implementation of the established strategic goals and influenced sustainable local development.

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Table 4. Selected indicators of sustainable municipal management

Lp.	Utilities management subsystem	Indicator name	Content	Measure
1.	Energy management	EG1	Dynamics of electricity consumption in the municipality in total from 2017 to 2021.	%
		EG2	Dynamics of thermal energy consumption in the municipality in total from 2017 to 2021.	%
		EG3	Dynamics of electricity consumption per capita 2017-2021.	%
		EG4	Dynamics of thermal energy consumption per capita 2017-2021.	%
		EG5	Share of renewable energy in total energy consumption.	%
		EG6	Level of thermal modernization of public buildings in the municipality.	%
2.	Water and sewage management	WG1	Amount of water consumption per capita.	m^3/per capita/year
		WG2	Number of residents connected to the water supply system to the total population.	%
		WG3	Number of residents connected to the sewage network to total residents.	%
		WG4	Cost of purchasingwater.	zł/ m^3
		WG5	Cost of sewagedisposal.	zł/m^3
3.	Management of urban transport and road infrastructure	TG1	Density of the transportation network in the municipality.	km/km^2 (of municipal area)
		TG2	Cost of roadmaintenance.	zł/km
		TG3	Cost of roadaccidents.	zł/year
		TG4	Number of electric vehicle charging stations.	pcs
		TG5	Length of bicyclepaths.	km
4.	Housing-municipal management	MG1	Debt of municipal housing units.	zł
		MG2	Debt of municipal housing units per capita.	zł/ per capita
		MG3	Number of passive buildings in the municipality.	pcs
		MG4	Rental price of municipal housing (without utilities).	zł/m^2
		MG5	Number of locations of so-called patodevelopment.	pcs
5.	Waste management	OG1	Amount of waste generated.	Mg/year
		OG2	Amount of waste generated per capita.	Mg/per capita/year
		OG3	Amount of segregated garbage in the structure of total garbage.	%
		OG4	Cost of waste management PLN/ m3/per capita.	zł/per capita/month

Source: authors' work based on Borys (2005).

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Results of the research

The link between the concept of sustainable development of the municipal economy and the effects obtained from the activities or investments undertaken is mutual. On the one hand, the indicators are carriers of the concept of development, and on the other, they emphasise the opportunities that arise from their practical application, allowing a reliable assessment of the existing state, as well as a scientifically validated forecast of economic effects and social and environmental consequences. The following table presents the results of a survey conducted in the surveyed municipalities of Olsztyn County on the number of measures taken in the various subsystems of municipal management in terms of sustainable development.

Table 5. The number of actions taken by municipalities in creating a sustainable municipal economy between 2017 and 2021

Municipality	Subsystems of municipal management					
	Energy	Transportation and road infrastructure	Waste	Water and sanitation	Municipal housing	Total
Barczewo	2	8	4	4	1	19
Biskupiec	2	7	6	3	1	19
Dobre Miasto	2	12	3	4	1	22
Dywity	5	5	7	5	0	22
Gietrzwałd	3	6	4	4	0	17
Jeziorany	1	2	7	2	0	12
Jonkowo	1	5	5	3	0	14
Kolno	2	0	1	1	0	4
Olsztynek	3	9	10	5	1	28
Purda	2	3	6	6	0	17
Stawiguda	8	9	12	11	10	50
Świątki	1	2	3	2	0	8

The largest number of projects and activities in individual subsystems of municipal management in terms of sustainable development were made by the municipalities: Stawiguda (50), Olsztynek (28), Dywity (22) and Dobre Miasto (22). The smallest number of projects and activities in the field of sustainable municipal management were implemented by the municipalities of Kolno (4), and Świątki (8). Another activity of the study was to analyse 25 indicators describing municipal management in its various areas (Table 5).

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Table 6. Level of indicators of sustainable development of the energy economy in the surveyed municipalities

Municipality	Dynamics of indicators in 2017-2021				Level of indicators as of 31.12.2021	
	EG1 %	EG2 %	EG3 %	EG4 %	EG5 %	EG6 %
Barczewo	15	11	12	10	4	60
Biskupiec	17	14	15	11	5	65
Dobre Miasto	13	7	13	6	3	55
Dywity	24	12	20	10	7	85
Gietrzwałd	15	14	12	11	5	60
Jeziorany	12	7	10	8	4	45
Jonkowo	23	15	19	13	6	70
Kolno	8	5	8	5	3	40
Olsztynek	27	20	25	20	5	75
Purda	17	7	15	7	4	50
Stawiguda	34	25	30	22	8	75
Świątki	8	5	8	5	3	30

Note: A description of the indicators can be found in Table 4.

The analysis of the defined indicators of sustainable development of energy management in the municipality was based on the determination of dynamics (applies to indicators EG1, EG2, EG3, EG4) and level analysis (applies to indicators EG5, EG6) as of 31.12.2021. The highest dynamics of electricity consumption (EG1) in 2017-221 was recorded by the municipalities of Stawiguda 34%, Olsztynek 27%, Dywity 24%. The lowest dynamics of electricity consumption is characterised by the municipalities of Kolno and Świątki 8%. Regarding the indicator (EG2) relating to the dynamics of thermal energy consumption in 2017-2021, the highest level was recorded by the municipalities of Stawiguda 25%, Olsztynek 20%, Jonkowo 15% and Gietrzwałd 14%. Recalculating electricity consumption per capita (EG3), the highest dynamics of electricity consumption is characterised by the municipalities of Stawiguda 30%, Olsztynek 25%, and Dywity 20%. Regarding the dynamics of thermal energy consumption per capita (EG4), the greatest growth in the years under study is characterised by the municipalities of Stawiguda 22%, Olsztynek 20% and Jonkowo 13%. The highest share of renewable energy in total energy consumption in the surveyed municipalities (EG5) is characterised by the municipalities of Stawiguda 8%, Dywity 7%, Jonkowo 6%. The lowest level of share of renewable energy in total con-

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sumption, 3% in the municipalities, is characterised by Dobre Miasto, Świątki and Kolno. The highest level of thermal modernisation of municipal buildings (EG6) is characterised by the municipalities of Dywity 85%, of total municipal buildings, Stawiguda and Olsztynek 75%, Jonkowo 70%. Based on the above analysis, it can be concluded that in energy management, the greatest dynamics of consumption of both electricity and heat are characterised by the municipalities of Stawiguda, Olsztynek, Dywity and Jonkowo, where the economic sphere is developing very rapidly, where many business entities are being established. On the other hand, these municipalities are leaders in terms of thermal modernization of buildings and the share of renewable energy in the structure of total consumption (Table 6).

Table 7. Level of indicators of sustainable development of water and sewage management in the surveyed municipalities

Municipality	Level of indicators as of 31.12.2021				
	WG1 m^3/per capita/rok	WG2 %	WG3 %	WG4 zł/m^3	WG5 zł/m^3
Barczewo	28,8	99,9	59,0	3,69	9,46
Biskupiec	27,7	89,3	65,6	3,06	6,27
Dobre Miasto	28,5	93,9	74,7	4,30	5,55
Dywity	24,4	90,9	60,7	3,31	4,74
Gietrzwałd	33,0	95,9	88,1	4,11	9,56
Jeziorany	28,8	79,6	60,9	3,96	8,96
Jonkowo	32,2	91,5	63,4	3,82	6,11
Kolno	35,6	93,0	37,7	3,09	4,59
Olsztynek	28,1	95,7	81,0	5,30	7,48
Purda	27,5	76,8	46,8	3,45	5,57
Stawiguda	47,0	99,9	96,2	3,90	5,95
Świątki	28,6	78,7	34,2	4,11	8,30

Note: A description of the indicators can be found in Table 4.

The analysis of the level of sustainability indicators in water and sewage management in the municipality was based on 5 indicators WG1, WG2, WG3, WG4, WG5, as of 31.12.2021. The highest level of water consumption per capita is characterised by the municipality of Stawiguda, 47m3/per capita/year, and the lowest by the municipality of Dywity, 24.4 m^3/per capita/year. The highest percentage of the number of residents is connected to the water supply system in

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the municipalities of Barczewo and Stawiguda, 99.9%, and the lowest in the municipality of Purda, 76.8%. The worst situation in terms of the number of people connected to the sewage system characterises the municipalities of Świątki 34.2% and Kolno 37.7% of the total municipal population. The highest number of residents connected to the sewerage system characterises the municipalities of Stawiguda 96.2% and Gietrzwałd 88.1% of the total population of the municipality. The lowest average level of costs related to fees for water and sewerage services characterises the municipalities of Kolno PLN 7.68 (PLN 3.09 + PLN 4.59), Dywity PLN 8.05 (PLN 3.31 + PLN 4.74). The highest cost of fees characterises the municipalities of Gietrzwałd PLN 13.67 (PLN 4.11 +9.56) and Barczewo PLN 13.15 (PLN 3.69 +9.46) (Table 7).

Table 8. Level of indicators of sustainability of urban transport and road infrastructure in the surveyed municipalities

Municipality	Level of indicators as of 31.12.2021				
	TG1 km/km^2	TG2 ths. zł /year	TG3 mln zł/year	TG4 pcs	TG5 km
Barczewo	0,34	272,5	94	2	5
Biskupiec	0,38	277,5	85	1	12
Dobre Miasto	0,31	200	8,7	0	3
Dywity	0,27	107,5	46,9	2	16
Gietrzwałd	0,50	215	53,3	2	0
Jeziorany	0,76	930	25,9	0	2
Jonkowo	0,36	152,5	14,9	0	8
Kolno	0,20	90	8,9	0	0
Olsztynek	0,33	302,5	128,5	2	2
Purda	0,28	225	54,9	0	1,5
Stawiguda	0,54	300	45,2	0	25
Świątki	0,18	72,5	15,9	0	0

Note: A description of the indicators can be found in Table 4.

Regarding the management of road infrastructure and urban transportation, the level of 5 indicators TG1, TG2, TG3, TG4, TG5 was analysed as of 31.12.2021. The most developed road network in terms of road length per 1km^2 of municipal area (indicator TG1) is characterised by the municipalities of Jeziorany 0.76 km/km^2, as well as Stawiguda 0.54 km/km^2 and Gietrzwałd 0.50 km/km^2. The least developed road network has the municipalities of Świątki 0.18 km/km2 of municipal area and Kolno 0.20 km/km^2. The owned road network generates

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maintenance costs (TG2 indicator). The highest road maintenance costs are incurred by the municipalities of Jeziorany 930 thousand zloty/year and Olsztynek 302.5 thousand zloty/year and Stawiguda 300 thousand zloty/year. The lowest municipalities are Świątki 72.5 thousand zloty/year and Kolno 90 thousand zloty/year. The most dangerous road infrastructure expressed in accident costs (TG3 index) is characterised by the municipalities of Olsztynek 128.5 thousand zloty/year, Barczewo 94 thousand zloty/year and Biskupiec 85 thousand zloty/year. The lowest road accident costs characterise the municipalities of Dobre Miasto PLN, which is 8.7 million/year, and Kolno PLN, which is 8.9 million/year. Only 4 municipalities have 2 electric vehicle charging stations each (TG5 indicator), as many as 7 of the 12 surveyed municipalities do not have any electric vehicle charging stations on their territory. In terms of the length of bicycle paths, the most developed network has the municipalities of Stawiguda at 25 km, Dywity at 16 km, and Biskupiec at 12 km. Three of the 12 surveyed municipalities do not have bicycle paths (Table 8).

Table 9. Level of indicators for sustainable development of municipal housing in the surveyed municipalities

Municipality	Level of indicators as of 31.12.2021				
	MG1 Ths zł	MG2 zł/per capita	MG3 pcs	MG4 zł/m^2	MG5 pcs
Barczewo	643,8	6	0	2,3	5
Biskupiec	623	4	0	2,3	3
Dobre Miasto	365	4	0	1,3	1
Dywity	100	2	0	0,95	0
Gietrzwałd	91,7	3	0	1,9	0
Jeziorany	292,6	7	0	1,2	2
Jonkowo	144,2	2	0	1,5	0
Kolno	12,3	1	0	0,8	0
Olsztynek	642,5	8	0	2,4	6
Purda	136,5	1	0	1	2
Stawiguda	40,3	1	0	0,7	0
Świątki	122,3	3	0	0,8	0

Note: A description of the indicators can be found in Table 4.

The highest indebtedness of municipal dwellings (MG1 index) at the end of 2021 is characterised by the municipalities of Barczewo 643.8 thousand zlotys and Olsztynek 642.5 thousand zlotys. The lowest debt is characterised by the

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municipalities of Kolno PLN 12 thousand and Stawiguda PLN 40.3 thousand. The situation is similar in terms of municipal housing debt per capita (MG2), where the highest amount characterises the municipalities of Olsztynek 8 zlotys/per capita and Barczewo 6 zlotys/per capita. The lowest debt is characterised by the municipalities of Kolno, Stawiguda and Dywity. No passive building has been built in any of the municipalities (MG3 indicator). The highest rental costs for municipal housing (indicator MG4) characterise the municipalities of Olsztynek PLN 2.4 per square meter, Barczewo and Biskupiec PLN 2.3 per square meter, while the lowest rent is charged in the municipalities of Stawiguda PLN 0.7 per square meter and Kolno PLN 0.8 per square meter. Another aspect of sustainable development related to the so-called pato-development is the construction of non-functional, inconvenient living conditions with absurd solutions. These can be, for example, buildings erected too close to each other or apartments laid out without any logic, often full of faults and serious deficiencies. The largest number of buildings assessed as pato-development is in the municipalities of Olsztynek 6 and Barczewo 5 pcs. (Table 9).

Table 10. Level of sustainable waste management indicators in the surveyed municipalities

Municipality	Dynamics of indicators in 2017-2021			
	OG1 Mg/year	OG2 Mg/per capita/year	OG3 %	OG4 zł/per capita/month
Barczewo	3189	0,182	18	16
Biskupiec	3788	0,198	12	14
Dobre Miasto	5678	0,352	14	16
Dywity	844	0,075	14	13
Gietrzwałd	489	0,075	15	16
Jeziorany	1178	0,148	12	13
Jonkowo	356	0,050	15	12
Kolno	215	0,065	12	13
Olsztynek	1456	0,105	15	15
Purda	578	0,067	12	14
Stawiguda	999	0,125	18	12
Świątki	312	0,075	16	15

Note: A description of the indicators can be found in Table 4.

The municipalities that generate the most waste (OG1 indicator) among those surveyed are, Biskupiec 3788 Mg/year, Barczewo 3189 Mg/year, and Dobre Miasto 5678 Mg/year. The least waste is generated in the municipalities of Kolno

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215 Mg/year and Świątki 312 Mg/year. On a per capita basis (OG2 indicator), the most waste is generated per capita in the municipalities of Dobre Miasto 0.352 Mg/per capita/year, Biskupiec 0.198 Mg/per capita/year, and Barczewo 0.182 Mg/per capita/year. The least waste per capita is in the municipalities of Jonkowo 0.050 Mg/per capita/year and Kolno 0.065Mg/per capita/year. The highest level of waste segregation and recovery (OG3 indicator) characterises the municipalities of Barczewo and Stawiguda 18% of the total waste. The lowest level is characterised by the municipalities of Biskupiec, Jeziorany, Kolno and Purda 12% of total waste. The highest waste management costs (indicator OG4) from a resident's perspective characterise the municipalities of Barczewo, Dobre Miasto and Gietrzwałd 16 PLN/per capita/month. The lowest waste management costs are incurred by residents of the municipalities of Jonkowo and Stawiguda 12 zł/per capita/ month (Table 10).

As part of the summary, a cluster analysis was carried out using the Ward method of the studied municipalities in terms of similarity regarding the level of sustainable development. This analysis makes it possible to classify the studied objects in such a way that the municipalities in the same group are like each other and, at the same time, as different as possible from the elements in the other groups (Figure 5).

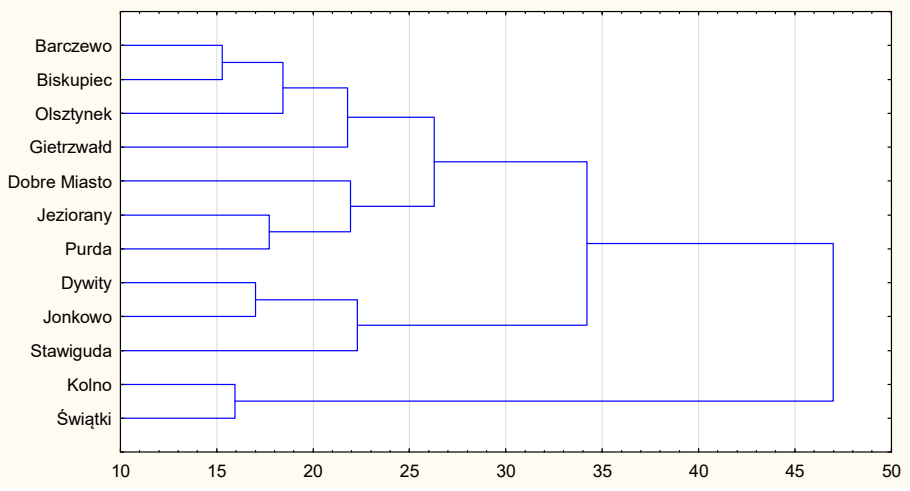

Figure 5. Cluster diagram of the surveyed municipalities in terms of sustainable development

Source: authors' work based on conducted research Tables 5-10.

At the aggregation level of 25, we can select 4 groups of clusters of communes that are most like each other in terms of sustainable municipal management. The first group of clusters are the municipalities of Barczewo, Biskupiec, Olsztynek and Gietrzwałd. The second group of clusters is Dobre Miasto, Jeziorany and

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Purda. The third group is Dywity, Jonkowo and Stawiguda. The fourth group of clusters are the municipalities of Kolno and Świątki. Jeziorany and Purda, Dywity and Jonkowo, Kolno and Świątki (Figure 5). Based on this analysis, we can conclude that the above clusters characterise the most similar municipalities from the point of view of sustainable development. Another analysis summarising the conducted research is the determination of the ranking of municipalities based on the class method and the analysed levels of indicators.

Discussion

In this article, we used indicator analysis to integrate municipal management with the goals of sustainable development and thus co-create local socio-economic development directions. To this end, we developed a new approach to analysing and evaluating municipal management from a sustainable development perspective based on five dimensions: energy, road transport, housing, water and sewage, and waste management. We defined the dimensions of municipal management from the perspective of sustainable development so that decision-makers would prioritise them in shaping investment policy and local development. We were inspired by studies conducted by researchers from various countries on sustainability and local economy issues, including Brzozowska et al. (2015), Palazzo et al. (2017), Frame et al. (2018), Reimann et al. (2018), Moyer and Hedden (2020). Existing research needed a new perspective and, at the same time, an approach to the municipal economy in terms of sustainable development in order to meet the current challenges of development in the local aspect and, at the same time, make them global (Allen et al., 2016). By defining sustainability goals through indicators and linking them to existing municipal management frameworks, we have provided a consistent yet practical method of analysis and evaluation that can be applied to the implementation of any sustainability goal. Our work has focused specifically on localising this framework to the local aspect, but we anticipate that the concept can be developed and operated at any scale. Given the variety of methods and approaches to how to measure the level of implementation of the Sustainable Development Goals, it can be noted that there is no single, synthetic and universal criterion for evaluating effectiveness. Due to the local nature of the municipal economy, there are several diverse conditions that affect its level of development, which in turn translates into specific actions of local communities.

Managing the sustainable development of a municipality requires making decisions that consider differentiated objectives, which in turn can be valued in terms of the level achieved.

One of the indicators proposed by the authors to assess the level of sustainable development achieved by municipalities is the indicator analysis, which comprehensively assesses the objectives achieved and, at the same time, provides a

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benchmark for other municipalities. Sustainable development is an activity that has no beginning and no end, and the multiplicity of objectives it pursues enables municipalities to create a sustainable development strategy that considers the most important priorities of the municipality.

Based on the research, a ranking of municipalities in terms of sustainable development has been carried out, defined by selected indicators that can be modified depending on changes in the internal and external environment of the municipalities (Table 11).

Table 11. Ranking of municipalities in terms of the level of sustainable development of the municipal economy

Wskaźnik	Barczewo	Biskupiec	Dobre Miasto	Dywity	Gietrzwałd	Jeziorany	Jonkowo	Kolno	Olsztynek	Purda	Stawiguda	Świątki
Total	11	10	3	2	4	12	7	8	9	6	1	5

Based on the indicator analysis, a ranking of communes was developed. The highest level of sustainable development in the municipal economy is characteristic of the communes of Stawiguda (1st place), Dywity (2nd place) and Dobre Miasto (3rd place). The lowest level of sustainable development in the municipal economy is characteristic of the communes of Jeziorany, Barczewo, Biskupiec and Olsztynek (Table 11), which are among the largest in terms of resources. As well as they have made the largest investment outlays in the researched areas over the last 10 years (2012-2021), including Biskupiec PLN 101.5 million, Barczewo PLN 62.3 million, Olsztynek PLN 58.3 million, Jeziorany PLN 50.5 million (Table 3). The research shows that communes with a high share of forest areas and water were characterised by a higher level of the analysed indicators, including this applies to communes such as Stawiguda (71.44% of forest areas and waters in the commune's area), Purda (60.27%), Dywity, Gietrzwałd (55.72%), Dobre Miasto (40.31%). This may indicate that the authorities and residents of the commune pay more attention to socio-environmental issues. Due to the local nature of the municipal economy and, therefore, many variables, it is advisable to deepen the analyses both in terms of the selection of indicators describing sustainable development in the municipal economy and the local conditions affecting their level.

The indicator approach to the analysis and evaluation of municipal management in terms of sustainable development has a high application dimension, is simple and understandable and therefore applicable and, at the same time, improves all communities and local businesses. In addition, it is open-ended in

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nature, which means that the model can be armed with other indicators based on the specifics of the municipality.

Conclusions

Today, sustainable development correlates clearly with local socio-economic development. Local governments are responsible for the effective implementation of the set goals in the economic, social, and environmental areas. The legislator allows the municipality to shape the municipal economy quite freely, through the implementation of various organisational and legal forms, which in turn can use a variety of solutions and innovations to effectively achieve the established goals of sustainable development. The possibility of individual shaping of processes in municipal management gives the local government unit the opportunity to maximise the economic and environmental effect in achieving the goals of sustainable development, although it must require self-control and prudence.

An important issue of implementation and monitoring of sustainable development in municipal management is the selection of indicators in its most important areas, i.e. energy management, water and sewage management, waste management, management of road infrastructure and urban transport or municipal housing management. The article proposes a model for analysing and evaluating the municipal economy based on expertly selected indicators (25 indicators) describing sustainable development. The indicators were verified using the example of 12 municipalities of Olsztyn district, and their use can be multiple. First, they make it possible to assess the actual level of a given parameter in each municipality, which makes it possible to evaluate the dynamics of change in a given time perspective, e.g., 3 or 5 years. Secondly, sustainability indicators can be an objective in themselves when planning the municipality's development strategy. Thirdly, indicators of sustainable development can be used when comparing municipalities, creating a ranking, and at the same time promoting best practices in sustainable municipal management. The analysis showed variation in the level of indicators describing sustainable development in the surveyed municipalities, both in economic issues related mainly to the price of municipal services, environmental issues related to the implementation of solutions related to energy savings and climate protection, and social issues related to the quality of life of residents. Considering the results obtained, one may be tempted to rank the surveyed municipalities in terms of the level of sustainable development.

Continued research will depend heavily on conceptual clarity to develop reliable and valid indicators to describe sustainability. In addition, monitoring depends on high-quality indicators (Mugellini et al., 2005). The proposed model for analysing and evaluating the level of sustainable development in the municipal economy is a kind of introduction to further research and, thus, increasing

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the number of indicators describing sustainable development in individual areas of the municipal economy.

The contribution of the authors

Concept, W.K.; literature review, W.K.; acquisition of data, W.K. and K.K.; analysis, interpretation of data, and modeling, W.K. and K.K.

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ZRÓWNOWAŻONY MODEL GOSPODARKI KOMUNALNEJ

STRESZCZENIE: Rozwój zrównoważony jest procesem dynamicznym, opartym głównie na zmianach ilościowych i jakościowych, w sferze gospodarczej, społecznej i ekologicznej, zgodnie z potrzebami i preferencjami mieszkańców gminy. Gospodarka komunalna stwarza natomiast korzystne warunki dla rozwoju lokalnego i stałej poprawy jakości życia mieszkańców. Celem opracowania jest analiza gospodarki komunalnej gmin z perspektywy koncepcji zrównoważonego rozwoju. Podstawową metodą badawczą zastosowaną w opracowaniu jest analiza wskaźnikowa. Wybrane do opracowania wskaźniki opisują koncepcję zrównoważonego rozwoju w fundamentalnych obszarach gospodarki komunalnej takich jak: energetyka, woda i kanalizacja, odpady, mieszkalnictwo komunalne, transport publiczny i infrastruktura drogowa. Badania zostały przeprowadzone w Polsce w województwie warmińsko-mazurskim w latach 2020-2022. Podmiotem badań jest 12 gmin powiatu olsztyńskiego. Na bazie uzyskanych wyników można stwierdzić iż najlepsze efekt w zakresie kreowania zrównoważonej gospodarki komunalnej uzyskują gminy, które zrealizowały największą ilość projektów w tym obszarze, jak również posiadające największy udział lasów i wód w powierzchni gminy m.in. Stawiguda, Dywity, Dobre Miasto, Gietrzwałd. Wdrażanie zrównoważonego rozwoju w gospodarce komunalnej zdeterminowana jest wieloma uwarunkowaniami o charakterze gospodarczym, społecznym, środowiskowym, przestrzennym i technologicznym. Badania umożliwią władzom samorządowym oraz decydentom praktyczne wdrożenie koncepcji zrównoważonego rozwoju w gospodarce komunalnej, mogą być również wykorzystane w procesie planowania inwestycji i podejmowanych działań lokalnych, uwzględniając przy tym aspekt gospodarczy, ekologiczny i społeczny. Badania stanowią podstawę do dalszych prac badawczych związanych z praktycznym wdrażaniem a zarazem zarządzaniem zrównoważonym rozwojem w gospodarce komunalnej.

SŁOWA KLUCZOWE: rozwój zrównoważony, gospodarka komunalna, gmina, wskaźniki

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