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THE CITY CHALLENGES AND EXTERNAL AGENTS.
METHODS, TOOLS AND BEST PRACTICES

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

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Editorial correspondence

Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

The cover image is Rue de Rivoli - an emblematic street of Paris connecting Bastille to Concorde – that since May 2020 has been reserved for bicycles and pedestrians, Paris, France, Saturday, Nov. 6, 2021.

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Co-creation of the green smart city concept. Analysis of the maturity of municipalities in the Polish-German borderland region

Ewa Łązniewska ^{a*}, Izabela Janicka ^b, Tomasz Górecki ^c

^a Poznan University of Economics

Poznan, Poland

e-mail: ewa.lazniewska@ue.poznan.pl

ORCID: <https://orcid.org/0000-0002-2784-2190>

* Corresponding author

^b Poznan University of Economics

Poznan, Poland

e-mail: izabela.janicka@ue.poznan.pl

ORCID: <https://orcid.org/0000-0003-4620-1935>

^c Adam Mickiewicz University

Poznan, Poland

e-mail: tomasz.gorecki@ue.poznan.pl

ORCID: <https://orcid.org/0000-0002-9969-5257>

Abstract

This article discusses the results of research conducted in the Polish-German borderland region regarding the ecological maturity of municipalities in 2020. Our main thesis is that the ecological strength of municipalities lies in the diversity of approaches taken towards solving problems related to environmental protection, and in the continuous activation of municipalities in their pursuit of the “green smart city” model, which in turn contributes to raising the standard of living for the residents. The aim of the study is an attempt to assess the activity of municipalities in the Polish-German borderland region via a tool for studying the ecological maturity of municipalities. The following milestones were adopted in the research: surveying municipalities in the Polish-German borderland area in terms of their ecological maturity, conducting a comparative analysis of the survey results, and formulating recommendations for the further development of municipalities and ecological policy.

Keywords

Local development; Sustainable development; Smart cities; Green smart city.

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1. Introduction

The project also yielded other articles that concern the theoretical aspect and criteria for assessing municipalities in terms of ecological activity and ecological maturity, which may be of interest to the current reader. This article presents the results obtained as a result of the study and demonstrates a practical approach to the application of the concept in order to study the ecological maturity of municipalities and to evaluate the eco-transformational processes.

The study provides an analytical framework within which to expand the emerging debates on supporting municipalities in their pursuit of the "green smart city" model, the various dynamics of sustainable development of municipalities, and the diversified development paths by comparing and contrasting many local eco-developmental routes for sustainable development taken by border municipalities using modern technological and other solutions in the Polish-German border area (Cappellano & Kurowska-Pysz, 2020; Kurowska-Pysz, 2018; Kurowska-Pysz, 2020). The literature does not contain broader debates regarding the concept of a "green smart city". It should be underlined that the concept of a smart and sustainable city was popularised in the mid-2010s by Höjer and Wangel (Höjer & Wangel, 2014) who identified five projects. These issues include: the globalisation of environmental problems and sustainable development, urbanisation and urban development, sustainable urban development and sustainable cities, information and communication technologies and smart cities (Fagiewicz et al., 2021; Jankowska et al., 2021; Peña et al., 2020). Extending the conventional perspective to include the eco-transformation of municipalities along with a fresh look at the processes of activating municipalities by developing various interesting developmental paths that a municipality may work into a harmonious model, offers a new perspective of recommendations for further research and conclusions for climate policy. Regional policy should focus on monitoring the progress of municipalities in the eco-development process and support various individual concepts arising from the project.

There are three key terms in the considerations, which are synthetically presented here. The first is ecological activity. A necessary condition for communes to achieve new goals and move to higher levels of eco-transformation is, on the one hand, supporting communes with specialist counseling services, e.g. in terms of new technological solutions available on the market, on the other hand – due to the high dynamics of economic and social changes – monitoring optional activities of municipalities that strengthen their pro-ecological image. The developed tool is a useful, but probably not the only possible solution to assess the ecological maturity of communes. Polish and German communes carry out numerous municipal tasks, directly or indirectly related to ecological goals, but also take initiatives beyond these borders. This article shows what can be called optional activity of municipalities. Maturity ecological is achieved when the commune does not violate the ecological balance, combining economic and technological while maintaining sustainable development. It is a permanent process that will last forever. Remember that technologies are only a tool for improvement, not an end in itself. Synthetically speaking, the presented subject of the article fits into the broadly understood issues sustainable and smart local development. The added value of the study is expressed through the described concept of the green smart city model, which may become a new development paradigm for municipalities, as well as the introduction to economic terminology of the concept of eco-transformation and the concept of green smart city. A "digital tool for measuring the ecological activity of municipalities" was also proposed in the pursuit of its ecological maturity. The ecological activity of municipalities may be accompanied by synergistic effects in the form of increased benefits from joint actions, co-competition, cooperation and strengthening competitiveness (Gargiulo et al., 2020; Kurowska-Pysz, 2020; Makkonen & Rohde, 2016; Moreno et al., 2021; Papa et al., 2015).

Unfortunately, as the research shows, cross-border character in the case of communes located on the Polish-German border it is often related to their location in the border zone, and has little to do with cooperation ecological environment of municipalities. While there are interesting projects, they are unfortunately not properly promoted. An example is the heating project from 2015, connecting Słubice with Frankfurt (Oder).

In the short history of their cooperation, which is only 30 years old, border communes experienced already that resistance to various crises, including ecological ones, is very important. As an example you can cite the current pandemic, flood or contamination from industrial or storage activities toxic waste. The examples developed by both of you may be interesting cooperation in the field of public services. European Union funds (currently Interreg) that support and create new ideas for cooperation (Ulrich, 2020; Ulrich et al., 2020; Ulrich & Scott, 2021). Border universities play a significant role in initiating projects – Collegium Polonicum (branch of Adam Mickiewicz University) and the University of Viadrina (Elbel & Ulrich, 2021). The communes in the Polish-German borderland, like others, strive to raise the level lives of their inhabitants and consider this task to be one of the most important (Churski, 2018; Churski et al., 2018). Their attractiveness results mainly from the richness of nature (reserves, parks, areas protected, forests, mountains, access to the Baltic Sea). There are many paths for transformation these municipalities, but ultimately they should seek to strengthen their most valuable resources and their protection, to build the image of communes attractive to investors and residents and small cross-border traffic, which is mainly Saturday-Sunday.

As a result of the preparatory work undertaken, two separate digital questionnaires were developed to assess municipalities on the Polish and German side. These surveys were based on face-to-face interviews, which at the outset demonstrated quite significant differentiation in areas of activity due to different approaches to problem solving or different stages of eco-development already attained by given municipalities. Furthermore, a supplementary questionnaire was created to verify the ecological activity of the residents. As a result, 11 German and 43 Polish questionnaires were analyzed. In total, 48 communes were included in the study.

The analytical work deals with several perspectives: classical, innovative and model. All these perspectives show the diverse involvement of municipalities in environmental protection processes, and thus in preventing the effects of climate change. The article ends with recommendations for further research and climate policy.

2. Method of analysis

The analytical research was based on a desire to explore the involvement of Polish-German borderland municipalities in the eco-transformation processes. Taking into account the accelerated pace of digitisation caused, *inter alia*, by the Covid-19 pandemic, the results of research on the ecological activity of several dozen municipalities in the Polish-German borderland may turn out to be interesting in this context, and may already provide a credible picture for analyses related to the ecological maturity of municipalities and their involvement in climate protection processes. However, as authors and researchers, we are aware that in order to obtain in-depth results, the entire borderland, which is highly diverse, would have to be included in the study. Due to the relatively slim budget of the project and the short implementation period (three months), it was possible to cover only 1/3 of the municipalities along the belt within four Euroregions: Pomerania, Pro-Europa Viadrina, Nysa-Szprewa Bóbr and Nysy. Unfortunately, the investigation of the German municipalities turned out to be extremely complicated for technical reasons.

It should be stated that the contact areas are economically and socially specific, and their development has often been historically inhibited. The state border in the west of Poland, after the Second World War, was a barrier that prevented the free movement of people and cross-border cooperation. This situation has changed over the last thirty years. Municipalities on the Polish-German border make use of green resources and develop tourism in many directions. This steers municipalities towards pro-ecological and infrastructural activities that strengthen the possibilities of cross-border communication. In this context, it should be recognised that this analysis has specific values, taking into account the uneven social and economic development, and in general the specificity of border municipalities as contact municipalities.

The article adopts the following analytical scheme:

- research issue: lack of knowledge about the ecological maturity of municipalities in the Polish-German borderland area;

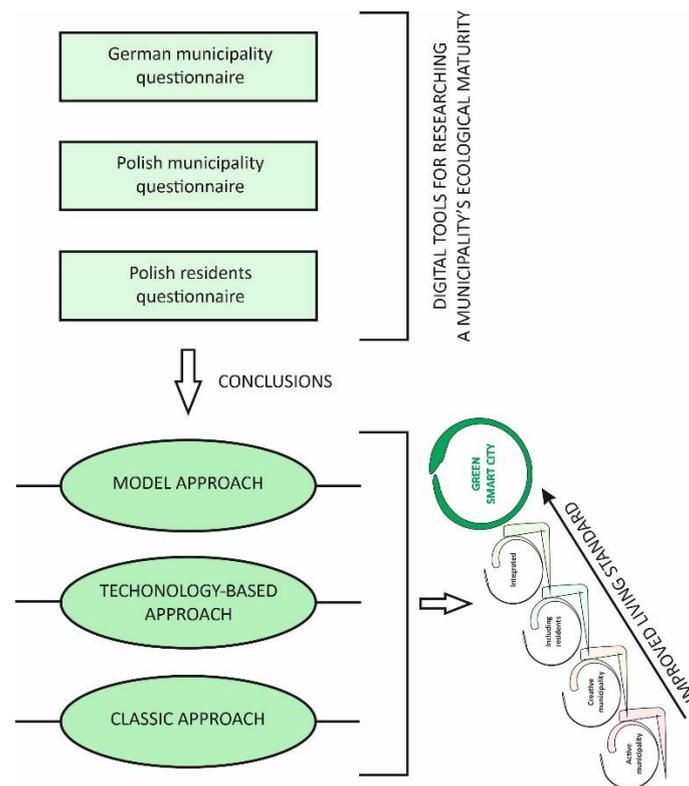


Fig.1 Research procedure. Source: Own study

- research goal: to investigate the activity of municipalities in four Euroregions towards their ecological maturity;
- research hypothesis: The eco-transformation process undertaken by municipalities is defined as their action taken towards a “green smart city”, which creates real opportunities for strengthening all areas of a model approach towards a municipality’s ecological maturity;
- the considerations are based on the concepts of smart city development as well as a range of concepts related to sustainable development. By critically analysing related concepts, the authors created the concept of a “green smart city” municipality, which closely links eco-development with smart development. The overall concept was adapted to the specificity of the development of border municipalities;
- the research method was tailored to the needs of the hypothesis and objective. Three different digital tools were proposed to study the action taken by municipalities towards ecological maturity. The study encompassed municipalities within the Polish-German borderland region. Due to extenuating circumstances, very little representative research was carried out among the municipality residents, which was mainly caused by limited financial resources and restricted time frames. Fig. 1 details the research procedure, which includes three stages: questionnaire research, conclusions drawn through three separate evaluation criteria and an indication of at which stage the municipalities found themselves along the eco-transformation process;
- the adopted assumption regarding the research tool. Due to the differences in the level of needs as well as the regional policy in Poland and Germany, and as a result of consultations with German partners, two different questionnaires were developed, which create varied criteria for evaluating processes, conditioned, inter alia, by legal conditions. These differences are shown in Table 1.

It should be underlined that the effects of eco-transformation should be considered in terms of measures and indicators that capture improvement in the quality of life.

Research themes	PL	DE
Waste management	x	Recycling since the 1970s, deposit system since 2003
E-communication by the municipality	x	x
Promotion of eco action	x	x
Care for biodiversity	x	x
Sustainable public transport	x	x
Green cross-boarder cooperation	x	x
Renewable energy	x	x
Inclusive growth	x	x
Water management	x	x
Air quality	x	x
Noise reduction	x	x
Eco education for the residents	x	Education is provided at schools
Thermal comfort	x	x
Smart technologies	x	x

Tab.1 Similarities and differences in the Polish and German questionnaires. "X" indicates compliance of the questionnaire in both cases. Source: own study based on surveys for German and Polish border municipalities

The questionnaire topics included in Tab.1 illustrate the fundamental issues concerning the "green smart city" actions undertaken by border municipalities. 20 questions were devised for the Polish, and 15 for the German, municipalities. In the interviews with the German side, some issues were omitted because they seemed obvious and had already been implemented a long time ago. The resulting differences result from the legal situation, the government system, the citizens' environmental awareness and the wealth of the state. Due to the long-standing "green" traditions in German policy, the extent to which the principles of sustainable development have been implemented may be higher and might not arouse any particularly social controversy. The Polish side is struggling to a greater extent with poor segregation of municipal waste or its environmentally hazardous disposal in home furnaces or illegal storage. There are many similarities, although they may differ in detail in selected research topics. One example would be e-communication. On both sides of the border it is possible to correspond with the municipal administrations, but the range of possibilities is much wider on the German side, which can be seen in the layouts of the German border municipalities' websites.

The drafting of the questionnaires was preceded by in-depth interviews with the Polish and German side. As a result of these interviews, the research technique established a priori based on the questionnaire could not remain identical in terms of quantity or quality, and clearly had to be modified. Closed questions contained technologically selected options that could be applied in the cross-border area under research. Some were intentionally cognitive and could serve as an indication of possible directions for solutions. From the point of view of the statistical evaluation criterion, the questions included some stimulant and destimulant explanatory variables. Filling out the questionnaire, besides the feedback given, was a kind of educational activity for the municipalities.

3. Ecological maturity map of the municipalities included in Polish-German borderland research

At the outset, one should note that the study included mainly small municipalities rather than large cities, which are characteristically unrelated to the type of municipality referred to by the smart city phenomenon (Drobniak, 2019). The study did not incorporate large cities where the level of pro-ecological action would

certainly be higher (one exception may be the medium-sized city of Frankfurt (Oder), but the digital tool would also have to be adapted to the city size.

The analysis of the obtained material, which is presented in map 1, gives a clear picture of the relatively low variation in the results, which is certainly influenced by the small share of German municipalities in the study, where we suppose that the main difference could occur. The differentiation appears greater when we look at individual criteria, which is discussed in the subsequent sections of this article. It should also be recognised that the municipalities revealed an average level of activity, which is the starting point for a discussion on the level of eco-transformation in the process of striving for a “green smart city”.

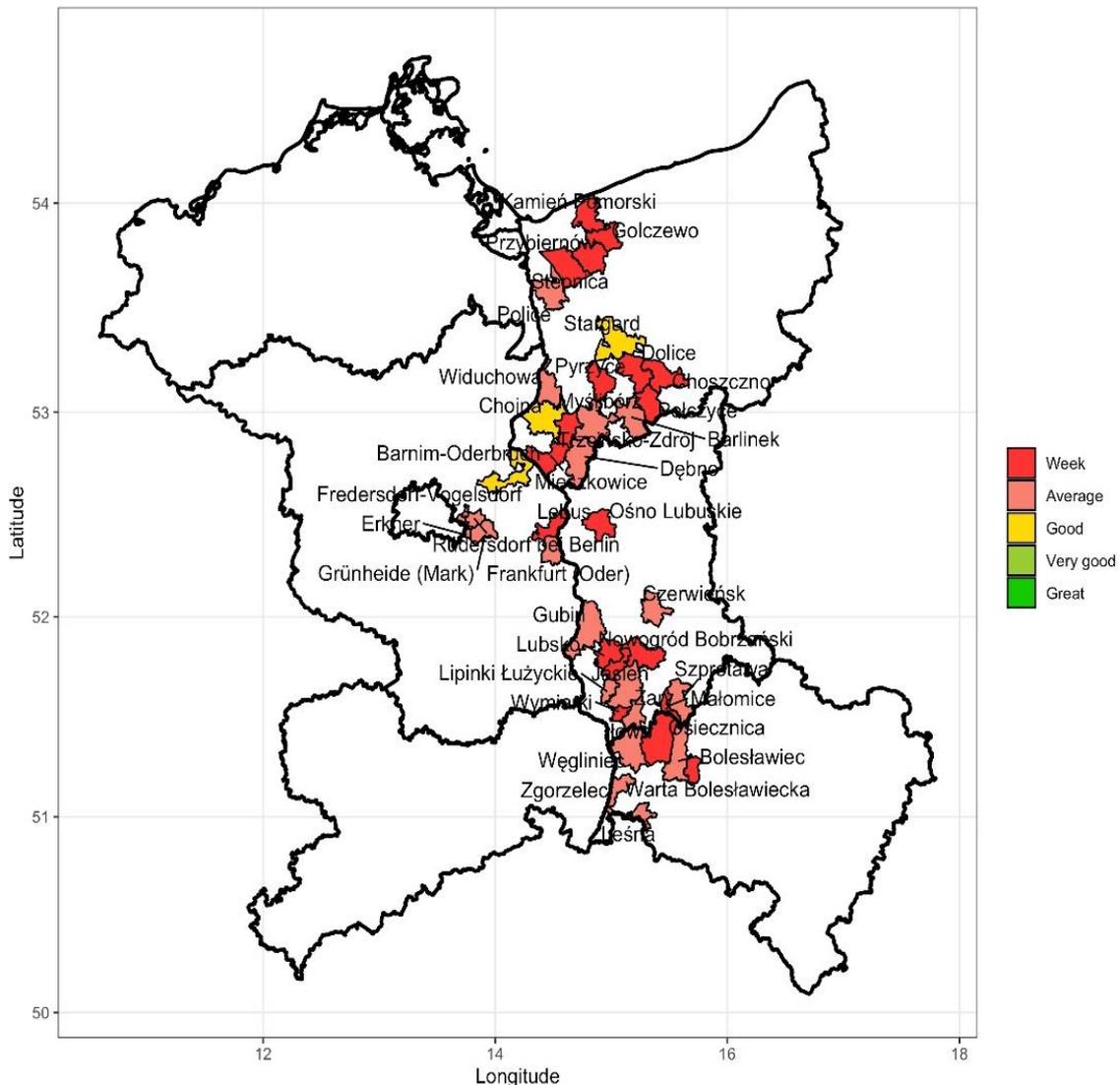


Fig.2 Activity of municipalities in the Polish-German borderland region. Source: Own study

4. Maturity analysis from the “smart city” perspective

The effects of climate change can broadly be divided into three groups: ecological, social and economic. The ecological effects of climate change include changes in vegetation types and the associated impacts on biodiversity; changes in afforestation density and agricultural production; expansion of dry areas; decrease in the quantity and quality of water; and risks related to pests, diseases and fires, a decline in water quantity and quality, and risks related to pests, diseases and fires. Social impacts can include changes in employment, equity, risk distribution and human health, as well as displacement of populations. Economic and economic effects include increased risk and uncertainty with regard to forestry and agricultural production, changes in

the productivity of crops and forest products, reduced supply of ecosystem goods and services, increased costs of utilities and services, and changed energy demand (Francini et al., 2020).

Due to the purpose of the study, the most important criterion when assessing the activity are digital technologies that municipalities propose to solve their own problems. In the literature on the subject, there are numerous critical discussions around the "smart city" of great diversity in understanding this phenomenon. and Smart City practitioners got involved in considering it through the prism of criticism. Criticism of "smart city" in the literature is noticeable on five levels: (a) conceptual methodological ambiguity, (b) utopian visions driven by ICT and corporations, (c) ignoring the potential of citizens and others, (d) "splintering urbanism", unequal representation, concerns about privacy and security, and the lack of a long-term vision for sustainable urban development adapted to local needs (Angelidou et al., 2017; Capasso & Mazzeo, 2020).

The *technological criterion* is the first to be analysed when assessing the activity of municipalities. First of all, from the point of view of economic practice and the observation of, for example, other entities, municipalities also need time to implement new technologies. Even in the case of large cities, these processes take place with a certain time delay. It should also be remembered that the processes of investment in innovative solutions are very expensive, which does not allow municipalities to reap benefits in a short period of time. Such investments should be seen as a long-term venture. Secondly, thanks to modern technologies, municipalities open up their "realm of possibilities" much further in various fields, e.g. economic, social and organisational.

Investments in information technology often require the introduction of changes in the municipality in terms of work organisation, communication, etc. These are expensive processes and, at the same time, do not always translate into boosting the municipality's competitiveness and improving the quality of life for its residents.

Thirdly, the implementation of digital technologies by municipalities may enhance some area of municipal activity, while not necessarily benefitting the functioning of the entire organism. It should be remembered that the analysed area of municipal activity in terms of the natural environment, is larger and more complex, in direct proportion to the size of the municipality. Fortunately, computerisation does not significantly affect rent dissipation, nor do the benefits grow at the expense of other municipalities. Here, a certain analogy can be made to competitiveness, which in the case of municipalities too does not directly arise from taking benefits from other municipalities, but these phenomena are much more complex. Finally, we can underline that decisions related to various solutions may turn out to be wrong. Lack of transformations in other areas of municipality management may reduce the overall benefits.

It is obvious that there will be more and less active innovators throughout the municipalities. The analysis of municipalities through research of action undertaken has yielded some highly interesting results. Four areas were taken into account in the analysis. In terms of "green" aspects, the following areas were selected to evaluate the activity of municipalities in borderland regions: smart management, smart living, smart environment, smart people. These are critical areas from the point of view of improving quality of life for the residents, as they all involve measures taken by the municipality to eliminate the negative consequences of climate change.

- In the *smart management* (Anthopoulos & Fitsilis, 2014; Janc, 2019; Sharifi, 2019) category, the active use of information and communication technologies in public services, which motivate residents to participate in eco action in the municipality, was studied. This category also includes economic waste management, which takes into account the requirements of the circular economy (Henry et al., 2020; Moraga et al., 2019; Vence & Pereira, 2019). Also of relevance is the activeness of municipal authorities in acquiring external funds for ecological projects, training municipal administration employees in the field of ecology, as well as regular cooperation with environmental organisations and specialists in the field of sustainable development. An efficient system of municipality management is based on co-governance and cooperation between residents and other city users, establishing appropriate procedures

that require cooperation between citizens and local authorities, and the willingness to use innovative technologies that help a given town function.

- *Smart living* (Anthopoulos & Fitsilis, 2013; Sharifi, 2019; Tokody & Mezei, 2017) includes all action taken to create a friendly climate for people and improve their quality of life, taking into account ecological balance. In this category, the municipality's endeavours regarding sustainable transport, diversification of energy sources, including renewable ones, and the introduction of modern architectural solutions in the biophilic design style (Kellert et al., 2008), also known as low environmental impact design (Kellert et al., 2008).
- The municipality's concern to reduce the level of carbon dioxide emitted to the atmosphere, expand green areas and guarantee clean water supplies and protect its resources fall within the *smart environment* category (Camarinha-Matos et al., 2019; Castanho, 2019; Gajdová et al., 2016). This area also encompasses all operations undertaken by the authorities, in cooperation with the residents, to reintroduce native species of animals and plants and protect endangered species. The systems used to reduce water consumption, the respect of natural resources and the use of renewable energy sources as well as the optimisation of energy consumption via modern technologies and the promotion of environmental education are all evaluated here.
- The final model category, referred to as *smart people* (Aletà et al., 2017; Sharifi, 2019; Tokody & Mezei, 2017) concerns the municipality residents who become conscious participants in ecological transformation through the process of their activation and education. Given appropriate technical facilities, they are able to reduce excessive energy consumption and environmental pollution and strive to improve their quality of life. Lifelong learning becomes an immanent feature of smart people, as "that kind of learning will define the twenty first century and is not taking place in a classroom" (Jessen, 2011). Educational endeavours to raise a "young green generation" are also assessed.

Figg. 3a and 3b show how active the Polish and German municipalities have been in relation to the four smart categories. In the case of Polish municipalities, one general conclusion can be drawn: as the overall activity of municipalities increases, the share of individual categories increases.

Most municipalities are entering into a phase of using smart solutions to protect the environment at their own pace or they simply lack the courage and creativity to make decisions. In the case of small municipalities, the lack of advisory institutions and academic centres in the immediate vicinity may also be a relatively tough obstacle to overcome.

It is observable that all the solutions that are universally discussed as being standard for cities, for smaller municipalities still remain in the realm of plans, and maybe even are not considered for implementation in the long term.

Only two municipalities were included in the third group. One might note that they are not similar when it comes to implementing solutions in terms of the four categories under consideration. In the case of German municipalities (cf. Fig.3b), we take into account a far smaller group. Most municipalities manifest similar activeness, while the municipality of Borken, which is significantly more active, is an outlier. Its actions may be considered as exemplary. The municipality Borken took part in the survey as a municipality lying on the western border of Germany.

The activity of communes was divided into four categories, according to the percentage criterion, as indicated by the communes in their responses.

The weak ones were those that showed activity up to 25% of the answers proposed in the questionnaire; average are those which showed activity in the range from 25%÷50%; good from 50%÷75% and very good above 75%.

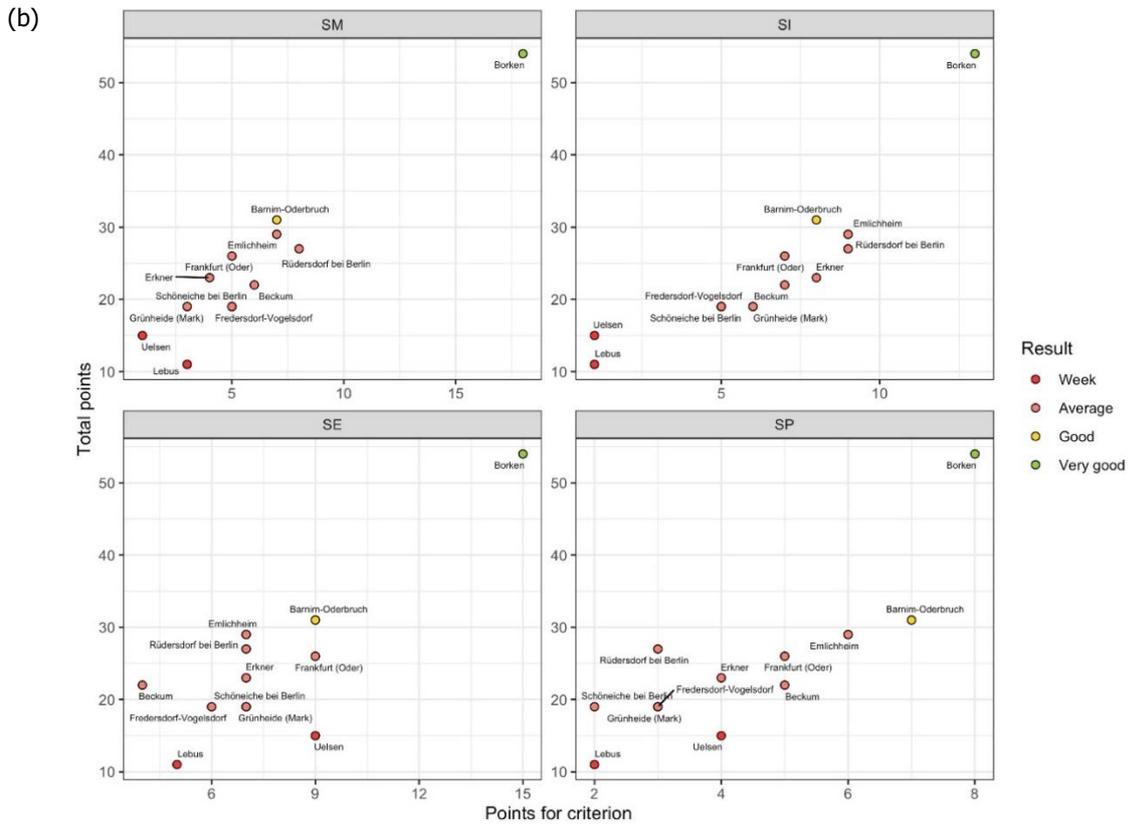
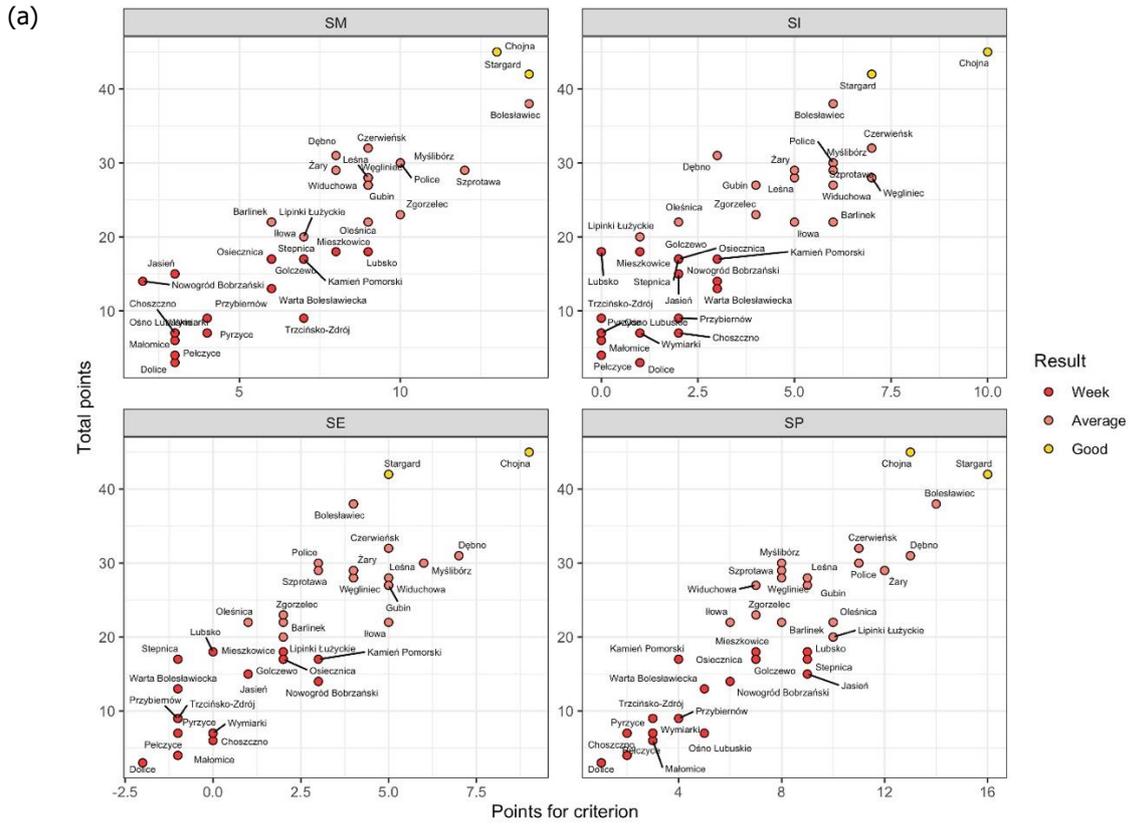


Fig.3 Number of activities undertaken by municipalities in relation to smart cities (a) Polish municipalities (b) German municipalities. Source: Own study

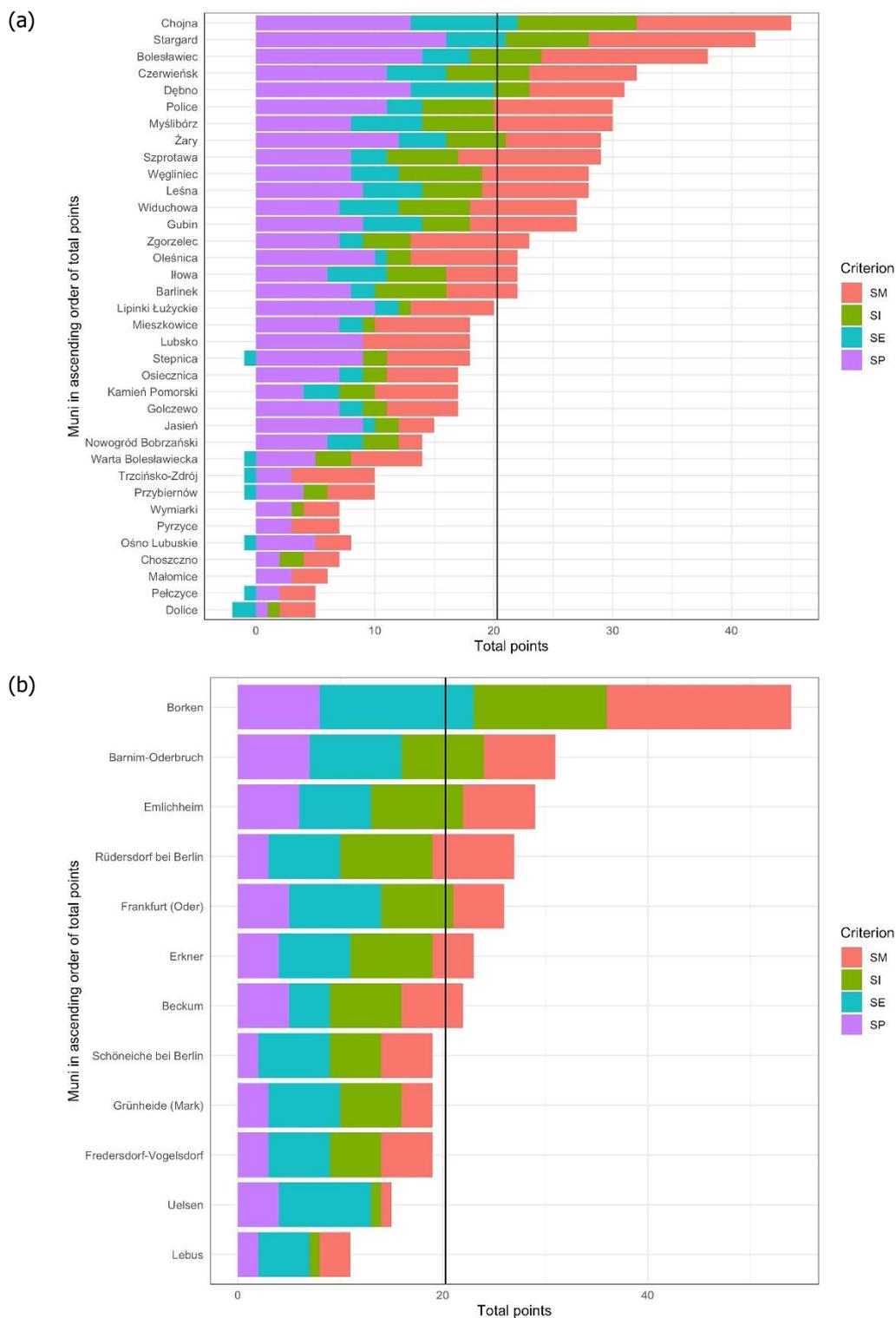


Fig.4 The structure of the activities undertaken by municipalities in relation to the smart city criterion (a) Polish municipalities (b) German municipalities. Source: Own study

From the analysis of Fig.4, we may conclude that municipalities manifest the greatest level of activity in the areas of SM and SP. One may also note that in the case of more active municipalities, their degree of involvement in the other two processes is growing, whereas in the case of less active municipalities this involvement is practically absent. It is significant that less active municipalities engage in actions that are unfavourable to the environment, yet in doing so probably consider these activities as environmentally-friendly (in this case, these are the activities indicated under the municipalities axis).

5. Analysis of ecological maturity in the classical approach

Classical analysis emerged in relation to protective measures for the Earth's natural resources, such as soil, water, air, and concern for the maintenance of ecological balance, understood as a "state of dynamic equilibrium within a community of organisms" (Verma, 2017). This criterion is related to resources and in this shape communes most often come to solve their problems in a task-oriented manner.

The so-called classical approach included the following areas for analysis:

- (1) Care for *soil*/quality should start with rational municipal waste management, including difficult, bulky and hazardous waste. An additional advantage for the municipality is the promotion and development of organic crops and their sale at local markets. Also, generally available composters are the simplest as well as being a cost-free method of managing excessive quantities of organic material. They contribute to the ecological nutrition of the soil. In a healthy environment, there is no concept of pest or disease, because all animal and plant organisms serve a specific purpose. The municipality's care for the protection or reintroduction of native species results in healthy crops, and thus the health of its residents. A question was also justifiably raised about the protection of biodiversity which, since the "Convention on Biological Diversity" announced in 1992 during the Earth Summit in Rio de Janeiro, has become one of the main areas of nature protection. Mowing lawns or raking leaves are popular forms of cleaning green areas, but these activities – apart from roads with limited visibility – are harmful and do not protect the soil and the microorganisms living in it.
- (2) Fresh *water*, accumulated in surface and underground resources, constitutes only 2.5% of the Earth's water resources. It must be retained in the soil and rationally managed for socio-economic purposes. Lack of action in this area may result in an increase in water prices. Cross-border cooperation in keeping border rivers clean is a 'green' added value.
- (3) The most dangerous results of *air* pollution are: smog, global warming and the ozone hole. An effective way to reduce gas and dust emissions is to reduce the extraction of fossil fuels and the burning of coal, and to increase the share of renewable sources in energy production. The actions of the municipality should be important for the health of its residents in terms of creating a real-time air monitoring system, minimising linear emissions by expanding cheap and accessible public transport to replace individual vehicles. Additionally, the expansion of bicycle routes, including cross-border motorways, not only connect neighbouring municipalities, but also significantly contribute to the improvement of air quality in forested border areas, which in turn is relevant to the development of tourism.
- (4) In the stationary state of the ecosystem, quantitative and qualitative changes of species occur very slowly, and in a given area there is a balance in the influence of humans and elements of inanimate and animate nature. Within the scope of maintaining the *ecological balance*, relevant action undertaken by the municipality includes: the use of green technologies, the maintenance of natural green belts, planning activities that reduce concreting, deforestation and noise levels.

The activity of communes was divided into four categories, according to the percentage criterion, as indicated by the communes in their responses. The weak ones were those that showed activity up to 25% of the answers proposed in the questionnaire; average are those which showed activity in the range from 25% -50%; good from 50% -75% and very good above 75%.

The conducted analyses show (cf. Fig.5) that the similarity in the activity of municipalities is particularly visible in action related to water management. Only one municipality is highly active, standing out among the entire group. In the case of German municipalities (cf. Fig.6), one may observe that for the majority, care for clean air and water resources are the most common forms of activities. Looking through the prism of the answers given, the most important issue for them is the development of bicycle infrastructure and electromobility – these are objectives that develop ecological municipal transport. Also the stormwater system, the water-tightness of sewage installations and the management of used water stand at the forefront of their plans.

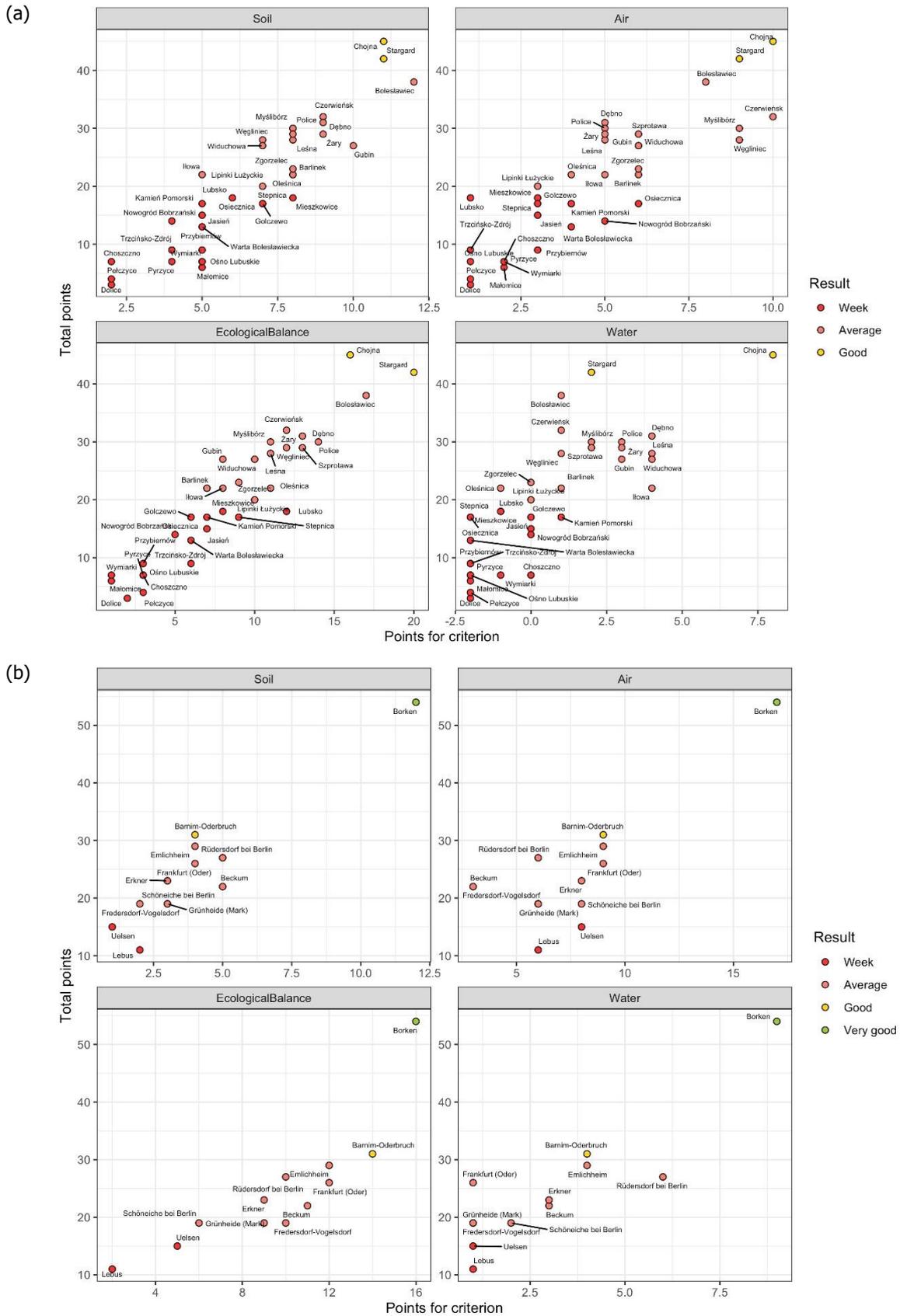


Fig.5 Number of actions undertaken by municipalities in individual areas of “the classical approach” to the total activity of a municipality (a) Polish municipalities (b) German municipalities. Source: Own study

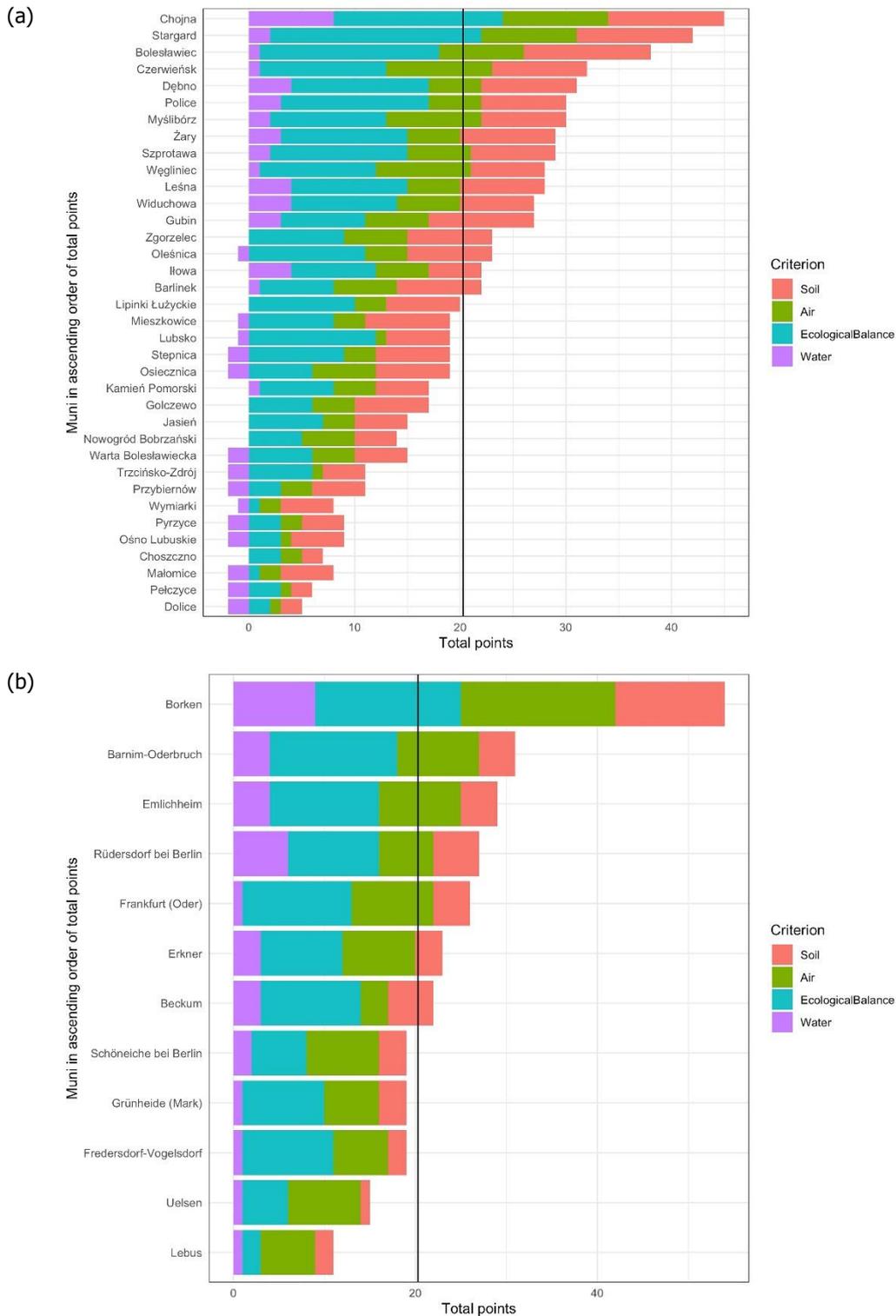
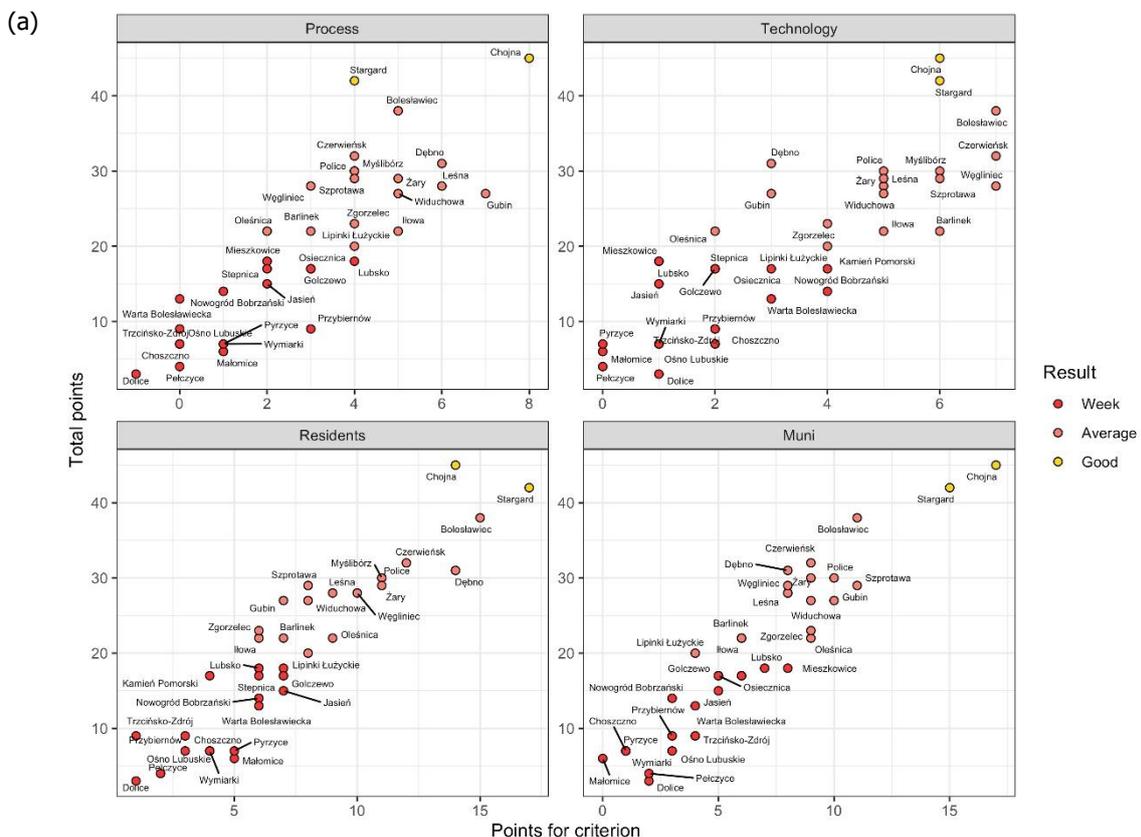


Fig.6 The structure of the activities undertaken by municipalities in relation to the smart city criterion (a) Polish municipalities (b) German municipalities. Source: Own study

Considering the structure of activity, and examining the issue from the point of view of the classical criterion (cf. Fig.6a), in particular areas, municipalities manifested the highest level of activity in questions related to ecological balance. Endeavours to retain water in the soil are poor. Further in the article, it turns out that these activities are extremely important for municipalities. In the case of German municipalities (cf. Fig.6b), maintaining the ecological balance is a challenge that most municipalities must face. This is not surprising due to the fact that too little has been done too late and the damage incurred in all ecosystems has been enormous.

6. Maturity analysis through the prism of the “green smart city” model

Our original approach to the study of ecological maturity involves looking at the problem from the point of view of four areas which determine good results, especially from the technological perspective. Good communication with residents, and the identification of many processes both in the municipality as an institution and its surroundings, should be supported by knowledge. The municipality authorities should create strategies that assume the municipality’s multi-stage ecological development. The solutions should include *technologies* that result in monitoring processes, improving communication, etc. In the second group, four more divisions were distinguished: processes, technology, residents, and municipal authorities. Big data and the Internet of Things support the operation of smart car parks, smart lighting, smart cross-border air monitoring systems or warning systems against natural disasters. The second element comprises the *processes* that determine the formula of activity, determined in an evolutionary mode of change, e.g. diversification of energy sources or air quality monitoring, the introduction of e-documents or information management. All based on the principle of sustainable development, they must be integrated and standardised. The other two links are *human resources* cooperating with each other, distinguished as: the *municipal authorities* and the *residents*. Building bonds and identification with the place of residence as well as horizontal cooperation in the borderland create a value that is timeless and immeasurable in terms of the levels of activity achieved. The “green” vision of its development depends on the creativity and entrepreneurship of municipal authorities. Conceptual work, the use of methods to activate municipal officials and openness to innovative solutions in cooperation with eco-specialists can build a new model of cooperation within the local government. The addressees and beneficiaries of effective management are the residents whose existence in a naturally preserved natural environment will definitely improve. Building social bonds and identification with the place of residence as well as close cooperation along the Polish-German border create a value that is timeless and independent of the levels of activity achieved.



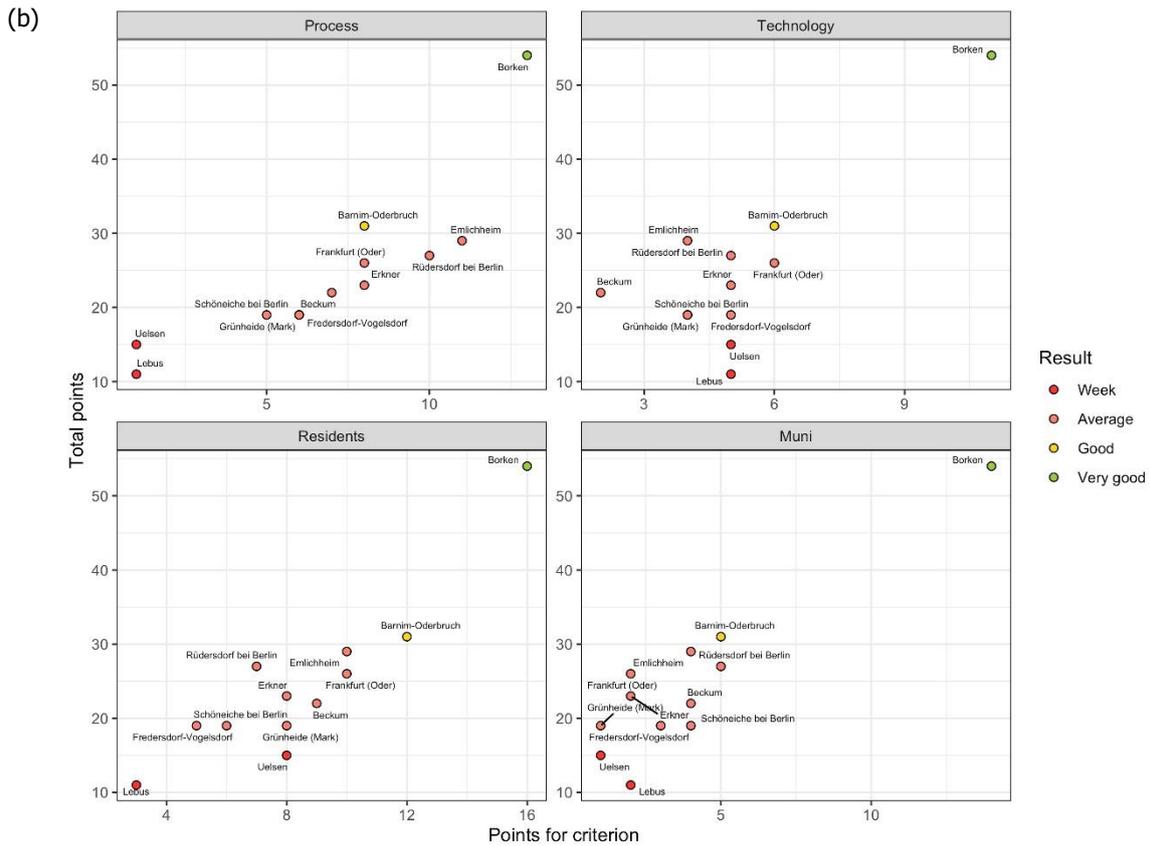


Fig.7 Number of activities undertaken by municipalities in particular areas of the “green smart city” model (a) Polish municipalities (b) German municipalities. Source: Own study

Considering the model approach related to analysis through the prism of the adopted criteria, municipalities differ quite significantly.

For the implementation of processes that may help municipalities attain the “green smart city” model, areas related to processes and technologies are extremely important. Here, the practices of large cities show that deficiencies in these areas are crucial for digital, autonomous solutions, etc. Fig. 7a clearly shows that the advancement of activity in terms of the discussed criterion is highly diverse. In the case of German municipalities, process synchronisation is difficult. Developing standards appropriate for this region may be of key importance due to the further development of both the German municipalities themselves and in the context of cross-border cooperation.

Considering the action undertaken by municipalities in particular areas, municipalities appear to be particular active in the area of human resources and municipality authorities. In this case, it should be helpful to study the residents to ascertain whether they manifest pro-ecological attitudes and if not, how could they be educated in order to systematically build such attitudes?

Also within the scope of the study, a digital tool for researching the ecological maturity of residents was created whereby residents can assess their pro-ecological attitude in areas such as: household, transport, and lifestyle. In this model, this is an area that complements the results obtained from the municipalities. In the case of Polish municipalities (cf. Fig.8a), Chojna stands out in terms of its particularly high level of activity. The residents and the municipality authorities are also particularly active. On the other hand, in the case of the German municipalities (cf. Fig.8b), the greatest level of activity also occurred to be in relation to the residents. From the contact points available where people may seek advice regarding energy saving methods and thermal imaging control of buildings, one might reach the conclusion that this is a trend that promises great economic benefits for residents, and thus for the climate.

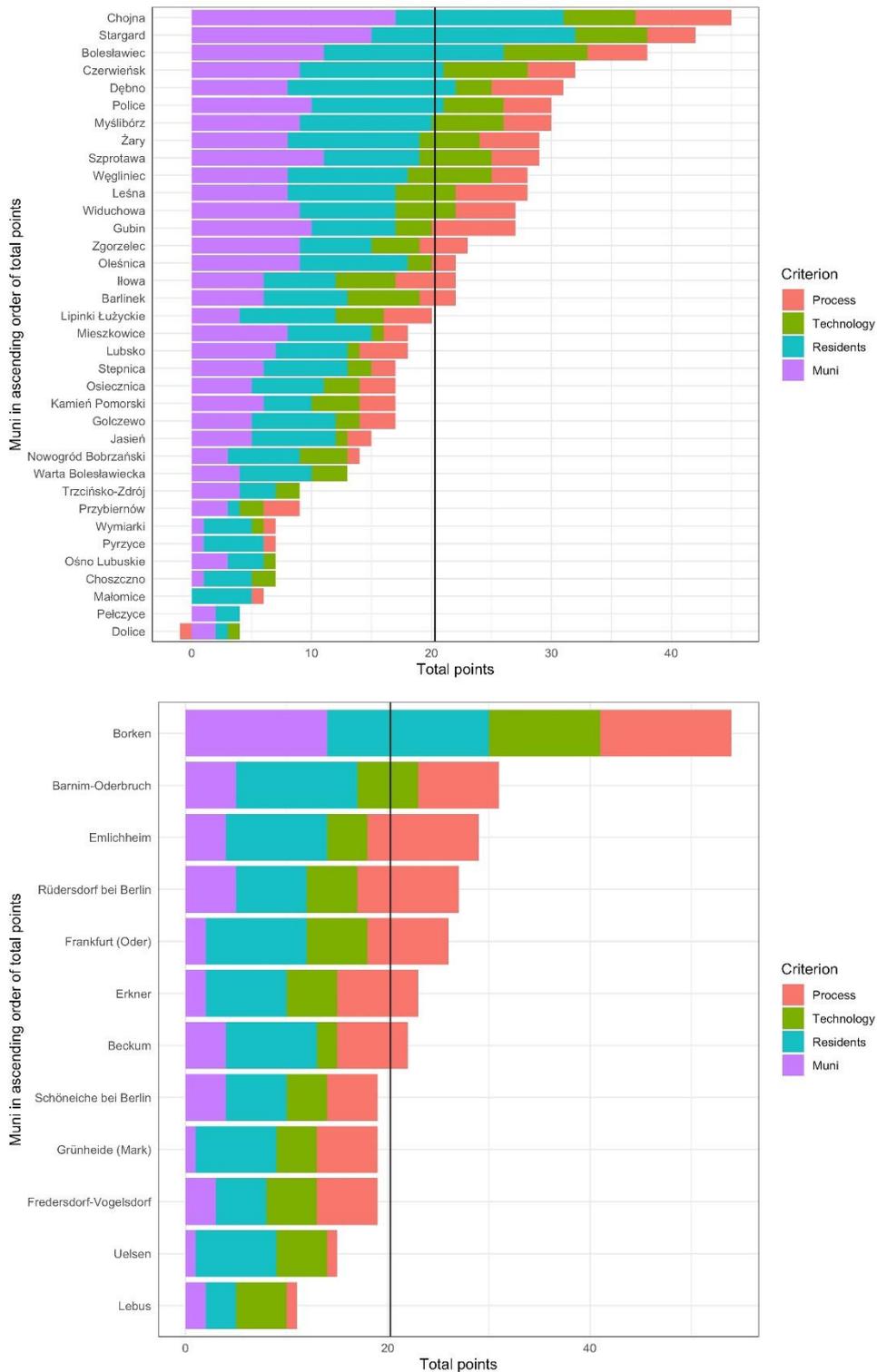


Fig.8 The structure of municipal activity in the so-called model criterion. Source: Own study

7. Eco-transformation processes in the Polish-German borderland

The stages of ecological maturity regarding municipalities in the Polish-German borderland region are related to their transformation in various areas: technology, the type of organisation that the municipality is, the residents, processes towards an open “green smart city” with an internationalisation of processes, process integration, orientation towards residents and raising their quality of life. An “open” municipality that creates new spaces for life and economic development undergoes self-assessment of its activity in the field of ecology. Through questionnaire research, it is possible to determine the developmental stage of a particular municipality (Fig.9).

We also discover what instruments it uses, in which areas it is particularly active (this has not been described, because it would require a highly detailed account, which is not the purpose of this article), in which areas it features developmental deficiencies, what strategies it adopts, etc. We learn that the municipalities demonstrate a somewhat average level of activity and are on their way towards further transformation. In the case of municipalities in the Polish-German borderland region, it is important that the survey contains some educational as well as incentive value.

Throughout the whole surveyed population of municipalities, what definitely came across as weak was the level of thought about pro-environmental development in the category of development challenges, i.e. eco-transformation processes.

All surveyed municipalities are characterised by the following:

- Among the solutions they apply, some are universal, e.g. initiating so-called “Mini Pszoks” in the area, promoting ecologically clean zones, access to public transport, protection of endangered species, installing LED lighting, conducting educational and offering opportunities for involvement, e.g. for seniors, planting plants that retain water in the soil, air monitoring systems, integrating planning activities, etc.
- Openness to residents’ initiatives, i.e. they are involved in decision-making processes and willingly take part in initiatives, such as: devising civic budgets, drafting maps where residents can actively highlight existing environmental problems, etc.
- Interoperability is the compatibility of the proposed systems with other similar solutions, mainly because the proposed solutions can be adapted to various digital environments.
- Virtualisation means moving most of the data and operations to a virtual space, which may include broadband internet, an integrated platform for servicing residents, mobile broadband internet (3G, 4G, 5G), availability of parking applications, and free Wi-Fi.
- The solutions applied should be based on autonomous (maintenance-free) concepts. This may include solutions in areas such as communication, waste management, and water resources. These concepts are particularly technically advanced and require a great deal of investment.
- Working in real time is a highly significant feature of this system. The possibilities offered by modern technologies, in particular by personal communication devices, facilitate better problem-solving, both for communication flow from town to citizens, and for collecting feedback.

The presented results and conclusions from the research are different for the examined Polish and German communes. First of all, the assessment should take into account different legal environment, economic possibilities, experience in solving ecological problems, etc.

The questionnaire results collected enabled the identification of four groups of Polish and German municipalities with different characteristics. *Active municipalities* incorporate ecological and economic solutions with varying results, because they face a number of obstacles. They could be much more active, but they lack maturity in the area of technology, and process while additionally hindered by insufficiently active or creative residents.

They are often weak in the organisational context. Many processes overlap. There is no transparency in terms of competences, no project approach or creativity in action. They are unable to find the right business models for municipal projects and lack a clearly defined development vision, strategy, etc. The needs of such municipalities are tremendous and they need to be supported by accurately identifying their requirements, gaps, obstacles, and environmental problems. The municipalities in this group are not always categorically weak in all of the areas mentioned.

Their position is primarily due to the fact that they have clearly formulated visions of ecological development. They need support and, first and foremost, external consultancy, greater openness to training, and also attempt to apply for funding for small soft projects that would pave the way for further development.

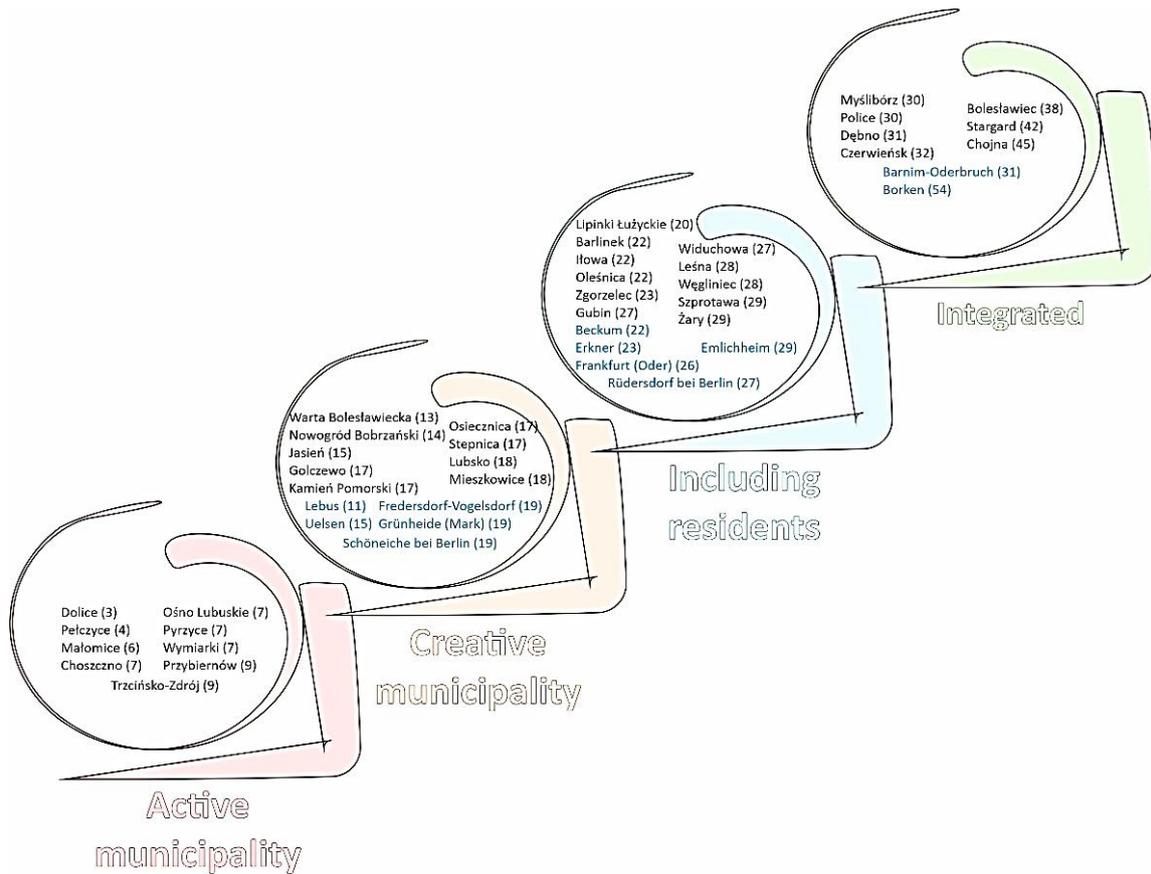


Fig.9 Eco-transformation processes aimed at increasing residents' quality of life. Source: Own study

Creative municipalities are much more involved in ecological development processes than active ones. They have digital and other solutions at their disposal that satisfy some of the residents' expectations. Unfortunately, these solutions are often random and have no logical consistency. They do not create harmonious systems that significantly reduce environmental problems. Again, help is needed to maximise the benefits of these different solutions. It may be claimed that these municipalities are on their way towards a "green smart city", but they need constant monitoring of their own actions, external advice from specialists in digital technologies, good and committed leadership, and the development of cross-border relations, etc.

Municipalities that include their residents assess their added value through the prism of the residents' strong involvement in the development processes. The benefits of this type of behaviour are significant in terms of better identification of problems, matching solutions to the needs of residents, residents identifying with the municipality, which has a positive effect on its image, etc. By joining the development processes, residents strengthen the municipality with their knowledge, competences, decisions on where to invest, etc. This is a stage in the development of municipalities that allows them to move further towards a "green smart city". Residents initiate, create new ideas, and monitor needs and expectations. Further efficient development depends on them.

Integrated municipalities see benefits in process integration, internationalisation and standardisation. They are keen to implement smart projects, which they incorporate into larger joint ventures, e.g. regarding mobility, waste management or water management. This is a process that is just beginning to develop among the front-runners. In Poland, large cities often face many difficulties in integrating, for example, communication services. The main aim of the model is a *green smart city*, which is the highest level as well as the most open to new solutions and cooperation. Resistant to external factors.

In the case of border municipalities, the socio-economic added value is visible through the mobilisation of endogenous potential by strengthening the local level as partners and initiators of cross-border cooperation, the participation of economic and social entities, environmental organisations and tourist agencies. Another

- focus on closer sharing of experiences and organising cross-border webinars dedicated to various groups of residents and municipality employees;
- searching for various solutions in the field of business models for ecological ventures;
- closer cooperation with the university community and pro-ecological organisations;
- supporting information flow within the municipality in real time;
- supporting projects undertaken in municipalities and initiating cross-border projects.

Specification	Polish municipalities	German municipalities
Air protection	Air monitoring system in the municipality of Dębna, implementation of an anti-smog program, co-financing of the replacement of solid-fuel furnaces with ecological furnaces, cooperation with a private geothermal project, the "Ośno Lubuskie Urzeka Klimatem" environmental education project on air protection	Air quality in the municipality is controlled along with free thermovision measurements in private premises and homes
Town greenery	New planting of trees and shrubs in parks and green areas, achieving a forest cover of about 49%	The green areas of the municipality are extended, including the expansion of flower meadows and windbreaks in combination with natural elements, without human interference. In agreement with the residents, protection of old trees is carried out in privately-owned areas along with the maintenance of natural and uncut grass, roadside green belts adjacent to public roads
Removal of asbestos	Widuchowa Municipality	=
Waste-water management	Co-finance for the construction of household sewage treatment plants from the municipality budget, the municipality co-finances the construction of household sewage treatment plants where there is no possibility of connecting a collective sewage system	A coherent model of water and wastewater management has been developed
Energy	Subsidies for residents for solar panels, replacement of street lighting with LED lighting	Development of Smart Grids which combine production, storage and consumption, and thus compensate for fluctuations in renewable energy. Public buildings have been equipped with energy-efficient lighting with motion sensors, and energy management systems have been revitalised, and green gardens have been installed on the roofs
Tourist infrastructure	Building a cycle path network	Within the scope of sustainable transport, the expansion of bicycle paths, charging stations and the expansion of the park of electric public transport vehicles
Eco-education	=	Support for the eco-education of the municipal administration officials and cooperation with eco-organisations
E-communication	=	E-communication was developed for Citizen Services along with advice points on energy management in private households
Virtualisation of space	=	There are wifi-hotspots in public areas and broadband internet
Water retention	=	Retention action is undertaken and the collection of rainwater for municipal needs is financially supported by financing reservoirs and reusing unclean water
Facilities for entrepreneurs	=	Tax benefits offered to eco-entrepreneurs

Tab.2 The current activity of Polish and German municipalities. Source: Own study

Added value resulting from the study of the activity of municipalities in striving for ecological maturity, manifests itself in:

- education of municipalities and residents;
- cognitive aspects;
- implications for regional policy;
- implications for cross-border cooperation in the field of ecology;
- identification of development niches;
- recommendations for entrepreneurs regarding investment opportunities in a given area, guidelines for formulating further directions of development;
- adaptation of specific solutions;
- influencing the change of the paradigm of process management in the commune from looking for causes changes in the natural environment by identifying processes at a given moment (through available information) for extrapolation and anticipation of future changes. Taking into account the considerations presented in the article, we can also refer to a number of them ideas that appeared here as debatable and difficult to incorporate by the communes, without being critical approach to many areas of knowledge, e.g. commune management processes, technology, macroeconomic specificity and mesoeconomics, behavioral analyzes.

As a result of the research conducted, several other implications emerged that may facilitate municipalities' eco-transformation process in the Polish-German borderland region.

They concern a deeper macro approach that could prove useful in the long run. Companies from this region that incorporate green solutions and smart technologies should be covered by a protective tax umbrella. Tax breaks or preferential loans for new enterprises may provide an economic impulse for the development of this region. This also applies to subsidies for organic farming, home crops and agritourism, which will boost employment and help keep young people in the area. Green actions undertaken by the residents and pro-ecological efforts exerted by the municipal authorities to maintain natural values may constitute an "ecological product" of this region. Highly specialised knowledge is required for a decent, economic and modern eco-transformation.

Within the scope of cross-border cooperation, it is worth establishing working groups of eco-advisers, whose knowledge municipalities should make use of. This is the best way to eliminate misguided investments, wrong decisions and a waste of public money. Also, digital solutions for intra- and inter-municipality communication as well as modern technologies introduced to improve the life of residents in changing climatic conditions can stimulate their creativity and willingness to cooperate. Transparency of decisions-making and the creativity of the leaders is also the key to changing the peripheral image of border municipalities.

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Author's profile

Ewa Łaźniewska

Professor at the Institute of Economics, Poznań University of Economics and Business. Establishes and runs an open interdisciplinary research environment connected with regional research and the digital economy. Operates international projects and commercialise knowledge in cooperation with business and administration. Publishes in scientific journals and have also authored six books. The latest one is currently in being published and deals with the relationships between the digital economy, resilience and regional development. Expert at the Ministry of Climate.

Izabela Janicka

Professor at the University of Economics in Poznań, works at the Department of Information Economics For many years he has been dealing with the issues of Polish-German relations after 1989 and the affairs of Germany's internal policy. Her research interests include forms of modern communication and political marketing. Author of postgraduate studies "Ecology in business", which introduce the issues of Circular Economy, sustainable development, clean production, CSR and building a green image of the company. Member of the Rector's Committee for Ecology. In 2016-2020, she was the chairman of the Poznań circle of the Green Party and a member of the National Council. The leader of the Green Party list in the 2018 local government elections and the party's candidate to the Sejm as part of the Civic Coalition in 2019.

Tomasz Górecki

Professor at the Department of Mathematical Statistics and Data Analysis, Faculty of Mathematics and Computer Science, Adam Mickiewicz University in Poznań. His main research interests include methods of artificial intelligence, machine learning and time series analysis and their applications. He has many years of experience in cooperation with industry, including Lidl

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and Samsung, where he worked, among others, on demand and inventory forecasting systems and intelligent voice systems. In addition, for many years he has been cooperating with specialists in other fields of science, such as economics, chemistry, geography, or transport, combining practice with theory. He is the author of over 80 scientific papers and 3 books.