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Analysis of the revitalization process of voivodeships in Poland based on UTASTAR and TOPSIS methods

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Abstract: Modern-day local governments face various challenges in the realms of geopolitics and socio-economic factors. Many times, intense transformations lead to crisis situations. Revitalization is a tool used by local governments to repair locally degraded areas. The paper focuses on discussing selected aspects of the revitalization process, using TOPSIS and UTASTAR methods. The study covered local government voivodeships in Poland and was based on secondary data for 2020-2021 published on the Statistics Poland website. The methods used made it possible to construct rankings that indicated that the voivodeships that could be considered leaders in revitalization are Greater Poland Voivodeship (UTASTAR) and Lubusz and Silesian Voivodeship (TOPSIS), whereas their opposite was the Opole Voivodeship.

Keywords revitalization, voivodeships, multi-criteria method, UTASTAR, TOPSIS

JEL H75, H79, I18

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Introduction

The complexity of decision-making imposes the need for various tools or methods aimed at minimizing uncertainty and streamlining the entire process while allowing the identification of the best or worst solutions. In this regard, the right approach is to use multi-criteria decision-making (MCDM) methods based on a linear algebra system (Abdullah 2014; Pohekar 2004).

The world witnesses a fast-paced and constant transformation. Areas undergoing intensive transformation are vulnerable to their degradation. Degradation, which is a long-term and diverse process, can manifest itself in the material, spatial, moral, or

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functional spheres (Roberts et al., 2017; Rogatka et al., 2022). The crisis situations in degraded areas force local government units (LGUs) to apply revitalization measures. The idea of the present study was to compare the level of revitalization based on selected indicators on a voivodeships scale using multi-criteria methods. The achievement of this research objective was made possible by a review of the literature on the subject and a multi-criteria analysis of the revitalization process, using the TOPSIS and UTASTAR methods in LGUs with a particular focus on local government voivodeships.

1. Literature review

Revitalization is a process at the intersection of many sciences. It is considered to be a restorative process aimed at socio-economic development as a result of actions taken in neglected areas that require intervention in both public and private areas. It is seen as a catalyst for socio-economic development and as a process that brings about changes in social and economic realities as a result of the implementation of coordinated measures in the area affected by degradation (Jaszczak, et al., 2021). As a comprehensive process, it combines activities from different spheres to develop a degraded area by transforming current and introducing new functions (Ciepiela 2019). The concept of revitalization embodies sustainable development in the social, economic, physical, and environmental dimensions of the problematic area as a result of its transformation (Haghighi Fard; Doratli 2022).

It is presented as an intricate, long-term, and capital-intensive process. It is treated as an important tool of a comprehensive nature that enables several transformations resulting in an improvement in the quality of life and the environment. The revitalization process is implemented when other measures do not meet the needs of an area that is degraded (Cunningham 2002a; Zheng et al., 2017).

The literature identifies the following dimensions of revitalization: social, economic, environmental, technical, and spatial-functional (Poczobut 2009). Similar to the degraded area, revitalization is a multifaceted management process that depends on many factors, which consequently pose difficulties related to its potential comparison (Boryczka 2017).

Revitalization processes depend on where they take place, both locally and nationally. They are also determined by the financial resources available and the form of human activity. As such, they differ in both the strategies they adopt and the results they achieve (Temelová 2009; Massey, 2019; Nzimande, Fabula 2020).

As Ciesiółka and Maćkiewicz (2022) argue, the revitalization efforts undertaken by post-socialist countries were characterized by disorder at the initial stage. In the case of Poland, the improvement came after accession to the European Union. Currently, revitalization activity in Poland is defined by a 2015 law. The complexity of the revitalization process determines the difficulties associated with its possible comparison across entities (Rogatka et al., 2022).

The need to make complex decisions as a result of the interaction of various phenomena dictated by intensive economic development led to the use of multi-criteria methods as early as at the turn of the 20th century (Łuniewska, Tarczyński, 2006). Multivariate methods organize selected variables according to a formulated

statistical measure, which allows comparative analysis of many different variants based on the adopted criteria (Keshavarz-Ghorabaee et al., 2015). Today, multi-criteria methods are used in many decision-making areas (Zavadskas et al., 2016; Taherdoost, Madanchian, 2023). They are used, among others, in construction, finance, or management (Tyrańska 2016). Tools that assist in the process of selecting the best option as a result of ranking various criteria include UTASTAR and TOPSIS methods (Beuthe, Scannella, 2001; Roszkowska 2011).

Among other things, the TOPSIS method has found application in choosing the right way to build certain facilities while taking into account the risk aspect (Tamošaitienė et al., 2013; Cho et al., 2022). It was also used in the selection process of efficient robots, where various variants need to be considered (Chodha et al., 2021). The TOPSIS method and its extension (Fuzzy TOPSIS) were used in supply chain management to accurately identify green suppliers (Pınar et al., 2021).

Furthermore, the authors used the UTASTAR method as a marginal aggregation tool to determine the efficiency of healthcare entities (Grigoroudis et al., 2012). Mastorakis and Siskos, (2016) used the UTASTAR method as an effective tool to support the decision-making processes of pharmaceutical company executives. Touni et al. (2019), using the utility function on which the UTASTAR method is based, discussed the selection of suitable stocks in the Iranian stock market. And by combining PLTS with the UTASTAR method, Liao et al. (2021), discussed the selection of suitable batteries for electric vehicles. Other authors discussed, using the TOPSIS method, the impact of the evolution of the e-commerce market in rural areas on the revitalization process (Feng, Zhang 2022).

Multi-criteria methods have also found application in the revitalization process. Lee et al., (2021) using the (AHP) method supplemented by SWOT analysis discussed possible strategies for revitalizing fishing villages. Some authors have used multi-criteria methods when discussing the development of post-mining areas to select the optimal use of such areas. Research in this area was conducted by Soltanmohammadi et al. (2008 a, b, c; 2010); Bangian et. al. (2012); Amaro et al. (2022). Similar conclusions were made by Soblewska and Walczak (2019), who used the AHP method to select the optimal way to develop degraded areas. Also, Palicki (2015) notes that multi-criteria methods to support an effective decision-making process can be applied already during the revitalization process when making various decisions. Furthermore, Liu et al. (2022) used TOPSIS and AHP to assess the revitalization of rural areas struggling with poverty in a Chinese province. An analysis of the revitalization process in various LGUs was also conducted by Rogatka et al. (2022), who used the multi-criteria AHP method as a tool. Therefore, it should be noted that the use of a multi-criteria method allows the calculation of a synthetic result, which, through the prioritization of variables, makes it possible to evaluate the process.

Although revitalization is a well-known process and multi-criteria methods are often used, the literature review indicates that there is currently limited research on comparing the effects of revitalization discussed from the voivodeship perspective. Accordingly, the main objective of this study was a multi-criteria analysis of the effects of revitalization at the level of local government voivodeships in Poland

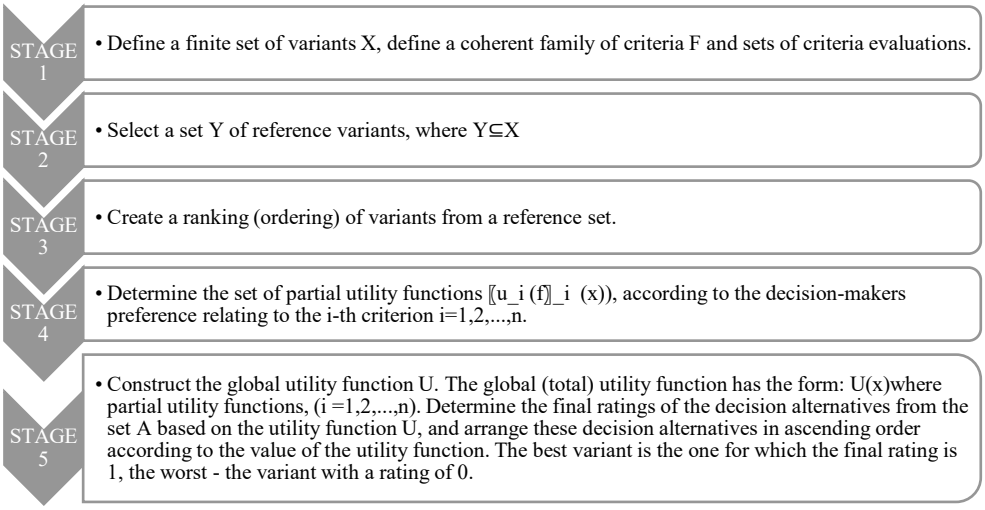
during the COVID-19 pandemic. The following research questions arise from the main objective thus stated:

- Which voivodeships ranked best in terms of selected aspects (scope and scale of activities) of revitalization in 2020-2021?
- Which voivodeships can be classified as benchmark and anti-benchmark in terms of activity in selected revitalization outcomes in 2020-2021?

2. Materials and Methods

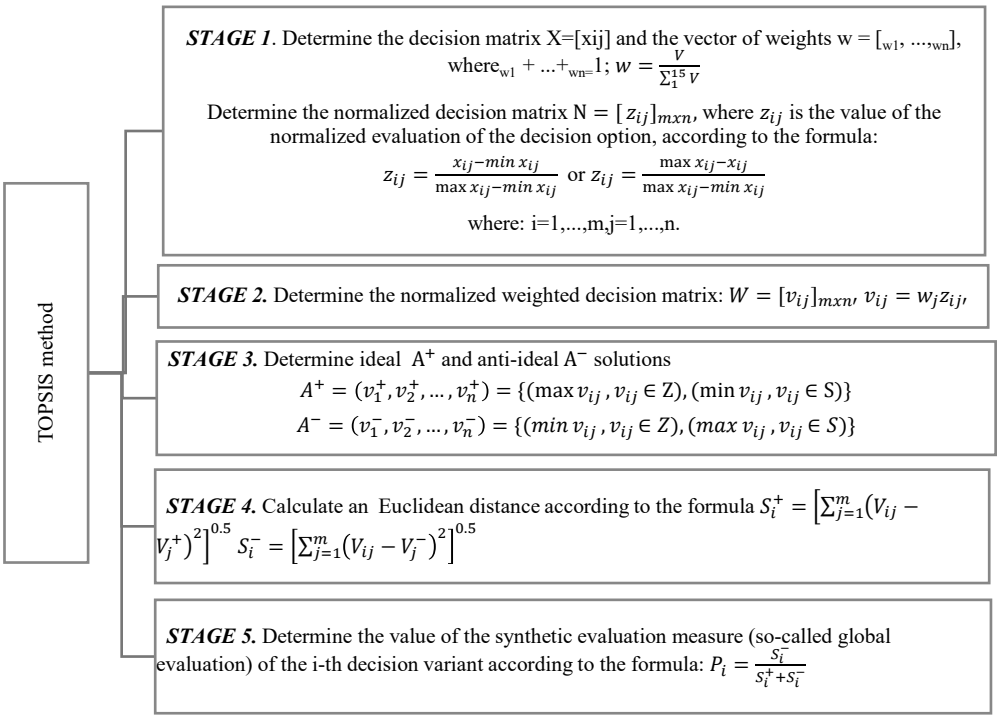
The indicator-based assessment of revitalization was conducted using secondary data found in the databases of Statistics Poland for 2020-2021, covering 16 local government voivodeships in Poland with the analysis (https://bdl.stat.gov.pl/; https://geo.stat.gov.pl/). The first stage of the research included a literature review using the triangulation method. The second stage focused on a preliminary comparative analysis of selected issues related to the revitalization process conducted based on descriptive statistics and the UTASTAR method. The third stage of the research focused on synthesizing selected effects of revitalization using the TOPSIS method. Both the UTASTAR and TOPSIS methods are among the multi-criteria methods that allow for the ranking of variants and selecting the most favorable options. The UTASAR method, developed in 1985, is derived from the UTA group of methods, based on the "disaggregation-aggregation" paradigm developed in 1982 by Jacquet-Lagreze and Siskos (Ehsanifar, Wood, Babaie, 2021). UTASTAR differs from the basic method in taking into account the disparity between the marginal utility variable of the following two values of all measures as an unspecified variable. Furthermore, to maintain compliance with the additive formula, it takes into account two instead of a single error (Xiong, Cheng, 2016). It consists of the following steps presented in Figure 1.

Figure 1. Steps of the UTASTAR method



Source: Own elaboration based on: Roszkowska, 2015

Figure 2. Steps of the TOPSIS method



Source: own elaboration based on: Filipowicz-Chomko 2021; Kacprzak 2018

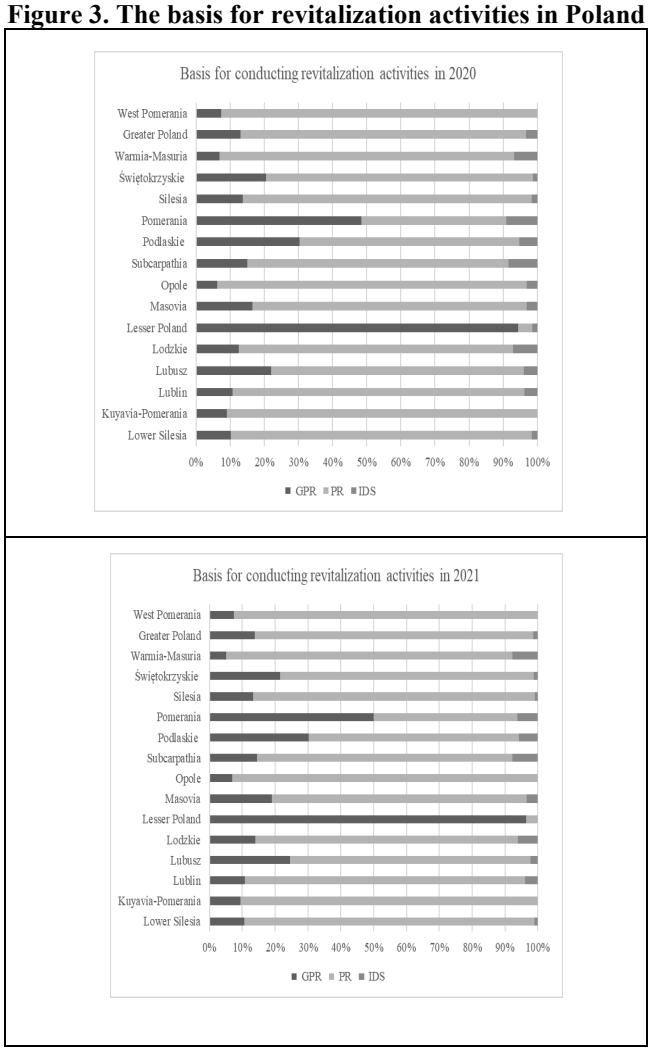
The second stage of the research consisted in constructing a synthetic measure, which allowed to select the positive ideal voivodeship (benchmark) and the negative ideal voivodeship (anti-benchmark) in terms of the effects of the revitalization process carried out by the TOPSIS linear programming method. The stages of TOPSIS research are presented in Figure 2. The Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) is classified as a linear normalization method that determines the positive and negative solutions for development based on multiple features (Misiewicz, Roszkowska, Rogowski 2019).

3. Results and discussion

Most of the local governments defined revitalization activity in revitalization programs (RPs). In 2020 there were 1135 RPs and the following year, the number decreased to 1067. The exception is the Lesser Poland Voivodeship, where the basis for conducting activities was the Municipality Revitalization Program (Gminny Program Rewitalizacyjny, GPR) 136 and 133 programs, respectively. The above data confirm the trend described by Cieślak-Arkuszewska and Purzyński (2022), who stated that local governments make little use of the law on the revitalization of

9 October 2015. A small percentage of municipalities in each voivodeship carried out activities based on other strategic documents (IDS), and their number in 2020-2021 averaged 41. Therefore, further consideration will be given to the revitalization measures taken based on the GPR and PR.

Figure 3. The basis for revitalization activities in Poland

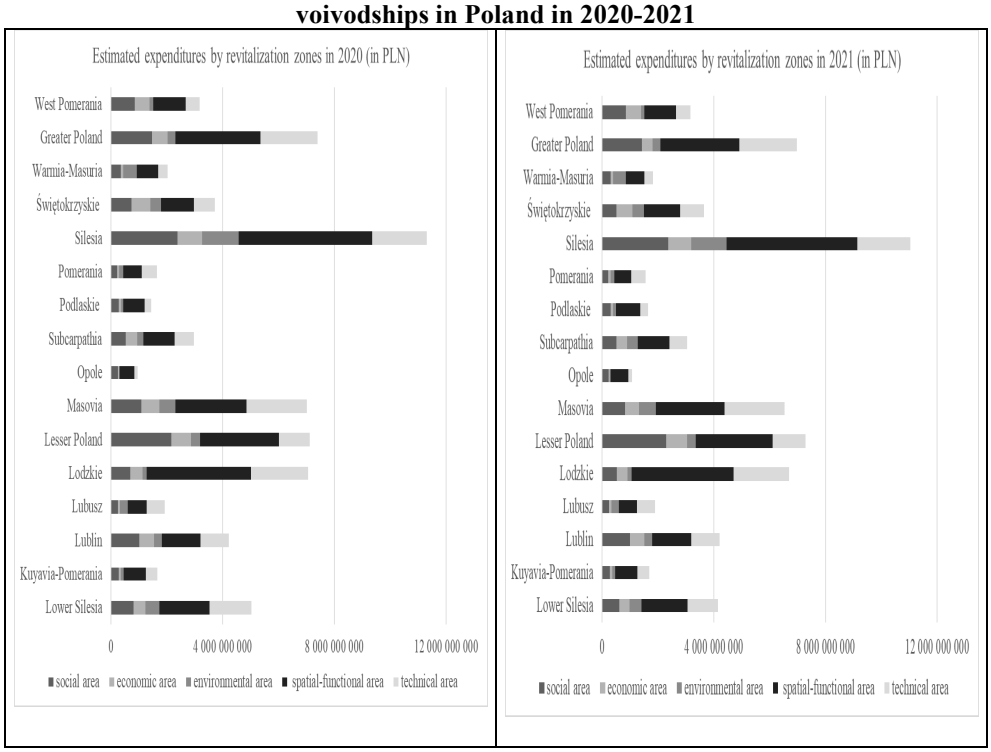


Source: own elaboration based on: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica

Taking into account the total area of intervention within the framework of revitalization activities in 2020-2021, the Silesian Voivodeship planned to spend the largest amount of funds over the entire period of revitalization projects, the value of which ranged from PLN 11,306,017,848.00 to PLN 11,030,801,204. The least funds for revitalization activities across the revitalization spheres were estimated by the Opole Voivodeship, with their value, despite the increase, not exceeding the level of

PLN 1,081,497,087.00. Considering individual areas of intervention, it can be noted that the Silesian Voivodeship planned the most funds for the following areas: social, economic, environmental, and spatial-functional, while the Mazovian Voivodeship - for the technical area. The opposite was observed in the Opole Voivodeship in the economic, environmental, technical, and spatial-functional spheres (2020), and the Pomeranian Voivodeship, in the social and spatial-functional spheres (2021).

Figure 4. Estimated expenditures by revitalization zones in local government voivodships in Poland in 2020-2021



Source: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica)

Local government voivodeships in Poland planned the most funds in the entire revitalization period in the spatial-functional area with an average of PLN 27,477,435,902.00, despite the fact that in 2020-2021, the largest number of completed or started projects focused on the social sphere. Second in terms of resource requirements was the technical sphere at PLN 15,858,384,600. In the years under review, the voivodeships estimated the least amount of funds allocated for activities in the environmental area at PLN 5,282,676,912.00.

3.1 UTASTAR method

The average area of the degraded area in 2020 was 236,588.38 hectares. In 2021, this number decreased by 9723.94 hectares. In half of the voivodeships in the period

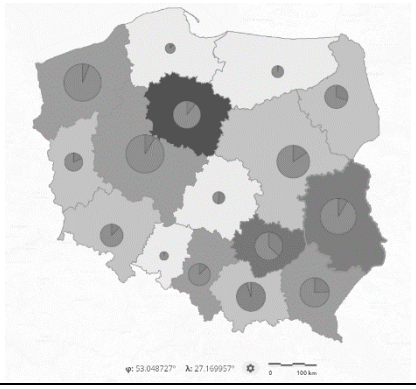
under review, the area of the degraded area was below average. The smallest degraded area was found in Opole Voivodeship, with 26,509.00 hectares and 13,481.00 hectares, respectively, while the largest area (more than twice the average) with 510,082.00 hectares in 2020 and 499,609.00 hectares in 2021 was recorded in Greater Poland Voivodeship. Despite this, in 2020-2021, the largest revitalization area occurred in Lublin Voivodeship, forming an average of 162,152.00 hectares, whereas the smallest revitalization area of 3462 hectares in Pomeranian Voivodeship was smaller than the average revitalization area for all voivodeships by about 20 times.

The highest number of revitalization activities was completed in 2020 by Lesser Poland Voivodeship (234), and in 2021 by Kuyavian-Pomeranian Voivodeship (258). In Lesser Poland Voivodeship, the largest number of completed activities focused on the social and spatial-functional spheres, which accounted for about 36% of the projects undertaken in the degraded area. A similar trend was seen in 2021 in Kuyavian-Pomeranian region, where the types of intervention focused on the social (44%) and spatial-functional (31%) areas. These results show the overall trend of interventions in each area. However, in both 2020 and 2021, the dominant area of intervention was the spatial-functional sphere oscillating around 35% and 34%, respectively. At a slightly lower level were interventions focusing on the social area (34%). During the research period, the fewest interventions focused on the economic sphere, with its level not exceeding 5% of all actions taken. Similarly, interventions in the environmental area accounted for 10%. The lowest percentage of completed revitalization projects in 2020 took place in Opole Voivodeship (26), followed by Łódź (49) and Lubusz (54) Voivodeships. In 2021, these were Lubusz (35), Opole (36), and Warmian-Masurian (36) Voivodeships.

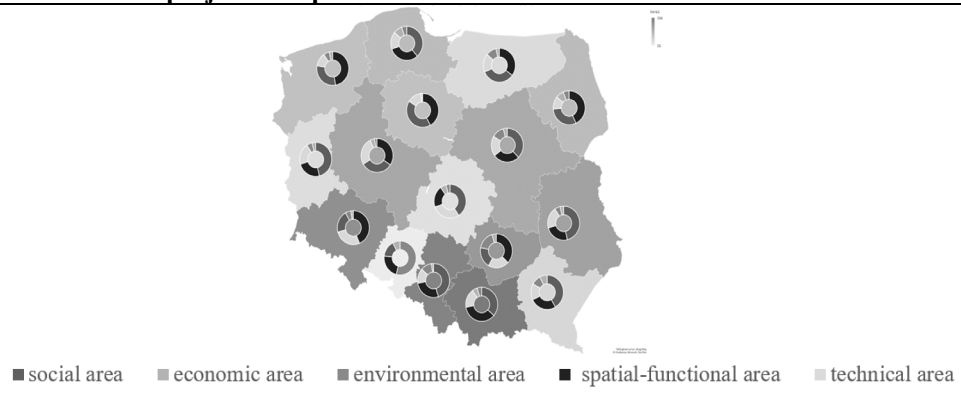
In 2020-2021, in addition to the completion of revitalization projects, it can be noted that local governments also undertook new initiatives in this area. In 2020, most projects were started by units located in the areas of Lesser Poland Voivodeship (646 units, with this voivodeship being also the leader in terms of completed revitalization projects in the period studied) and Silesian Voivodeships (605 units). Over the entire period, the least activities were undertaken in Opole Voivodeship with 70 and 80 revitalization projects, respectively (this voivodeship also completed the least revitalization projects in 2020). The leader in terms of initiated remedial actions in degraded areas in 2021 was still Lesser Poland Voivodeship with 574 (despite the fact that the largest number of projects were completed at that time in Kuyavian-Pomeranian Voivodeship) and Greater Poland Voivodeship with 560 new initiatives. A comparison of 2021 with 2020 reveals that local governments undertook fewer revitalization projects and their total decreased by about 7 percentage points.

Figure 5. Selected aspects of revitalization of local government voivodships in Poland in 2020-2021

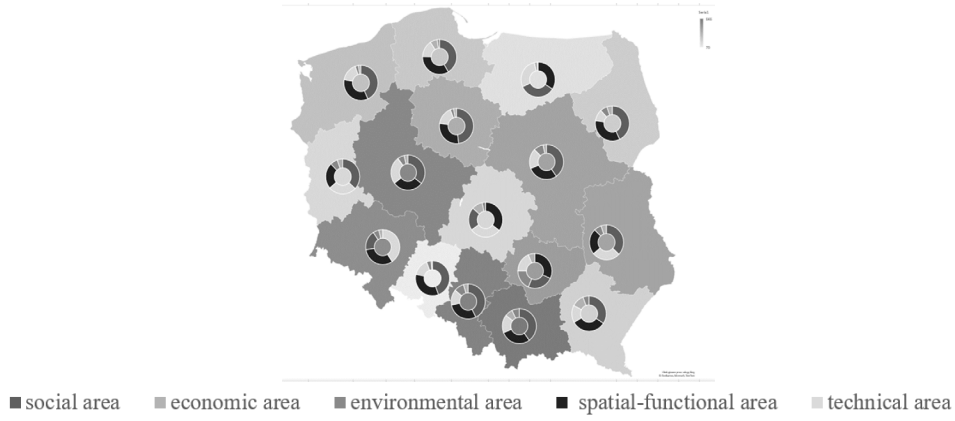
Area of revitalization and degraded area based on the PR and GPR in 2020



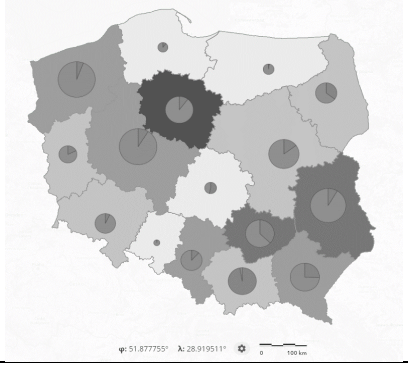
Revitalization projects completed in 2020



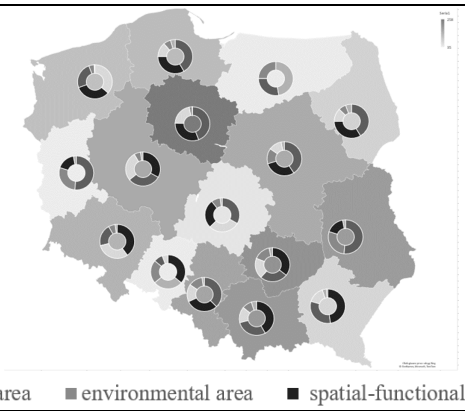
Revitalization projects launched in 2020



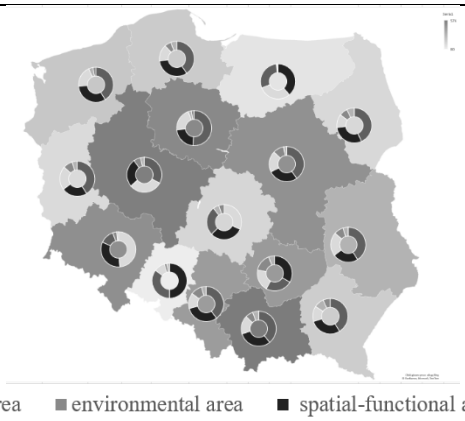
Area of revitalization and degraded area based on the PR and GPR in 2021



Revitalization projects completed in 2021



Revitalization projects launched in 2021

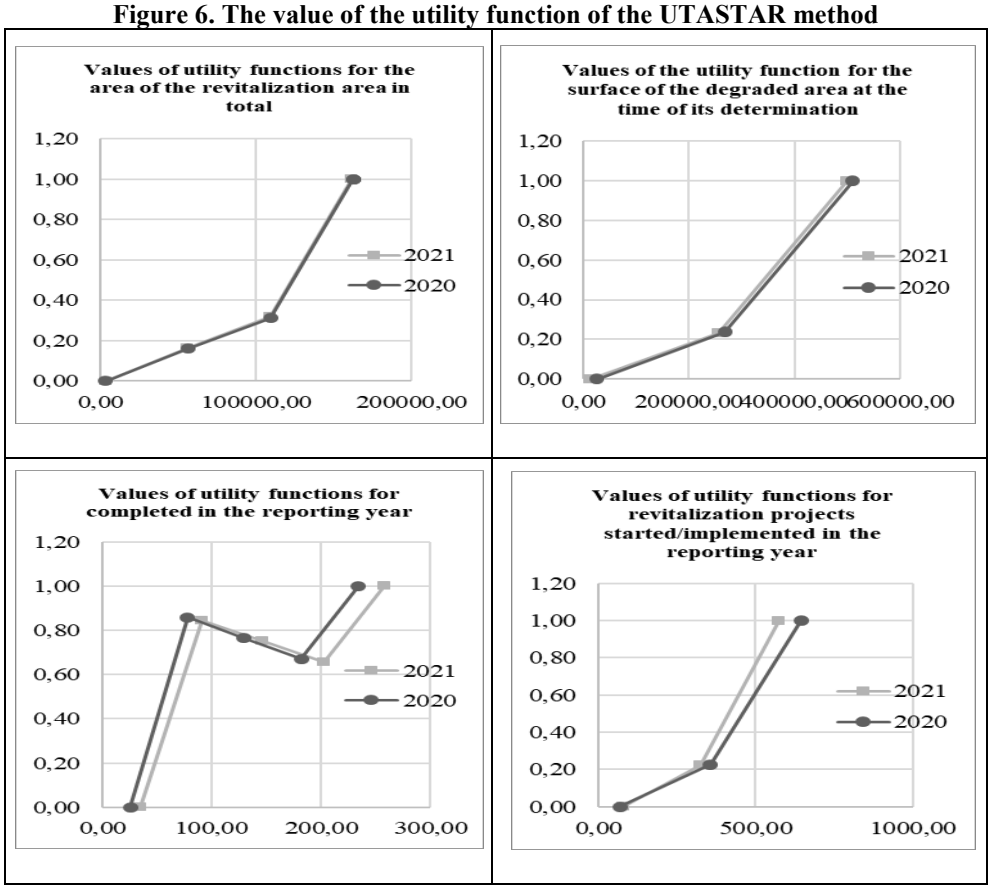


Source: own elaboration based on: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica; https://geo.stat.gov.pl/app/mapa/gus/c633a248-a094-0007-c39a-25d57ecdf0e4/?locale=pl&mapview=52.003319%2C19.424767%2C6.77z#/

Only in five voivodeships (Kuyavian-Pomeranian Voivodeship, with the largest increase of 34%, and Łódź, Masovian, Opole, and Subcarpathian Voivodeships); the

dynamics of changes were positive. The largest decrease in started revitalization investments was found in Lublin and Podlaskie Voivodeships (ca. 24%). The largest number of initiated projects (as in the case of completed revitalization projects) focused on the social sphere, which accounted for 36% of undertaken projects, and in the spatial-functional sphere, with 31% in 2020 and 30% in 2021. The fewest projects were observed in the economic and environmental spheres, which did not exceed 7% of all initiated interventions.

Figure 6. The value of the utility function of the UTASTAR method



Source: own elaboration based on: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica

The data compiled in Figure 5 were analyzed using the UTASTAR method. The flowchart shown in Figure 1 shows that when calculating the global utility function, variables for which $V \leq 10\%$ were defined first. The next step was to determine their reference values. The analyzed variants were then ranked in order from smallest to largest. The decision-makers preference was expressed by setting the maximum number of linear segments for each criterion. Based on them, the preference model

was established, which determined the profiles of all partial utility functions, which are shown in Figure 6. A ranking was then prepared.

Table 1. Ranking of self-government voivodeships in Poland based on the UTASTAR method

Voivodeship	*Value U(x)*	*Ranking 2020*	*Value U(x)*	*Ranking 2021*
Lower Silesia	0,403383304	8	0,389362528	8
Kuyavia-Pomerania	0,578634846	3	0,601749114	3
Lublin	0,770797605	2	0,732086903	2
Lubusz	0,164723627	13	0,072400311	14
Lodzkie	0,119648835	15	0,084189115	13
Lesser Poland	0,546592809	4	0,465133935	5
Masovia	0,406621562	7	0,415218273	7
Opole	0,001916936	16	0,004888307	16
Subcarpathia	0,308090681	10	0,327341677	10
Podlaskie	0,279525735	11	0,259227291	11
Pomerania	0,196745637	12	0,196681329	12
Silesia	0,461470082	6	0,349664124	9
Świętokrzyskie	0,39006575	9	0,432493597	6
Warmia-Masuria	0,131409244	14	0,019543158	15
Greater Poland	0,874024189	1	0,875384905	1
West Pomerania	0,543482864	5	0,551390484	4

Source: own elaboration based on*:* https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica

Analysis of the data in Table 1 shows that in terms of the variables in question in the developed ranking, the first place was occupied by the Greater Poland Voivodeship, while the Opole Voivodeship ranked last.

3.2 TOPSIS method

Following the methodology presented in Figure 2, the synthetic index of the TOPSIS method was determined by initially identifying the variables presented in Table 2. Due to the information potential of the variables, they were analyzed based on the coefficient of variation, for which $V \leq 10\%$, assigning a weight to each variable. The next step was normalization performed using the min-max method and, taking into account the weights, the matrix was determined. Then, based on the positive and negative ideal solutions, Euclidean values were calculated, which consequently enabled the construction of a synthetic measure for which the values range from 0 to 1 (Shekhovtsov, Salabun, 2020).

Table 2. Variables used in the TOPSIS method

Variable – stimulant
1. Number of people assisted;
2. Number of jobs created;
3. Number of facilities where asbestos roofing was removed;
4. Number of apartments where heat sources (e.g., solar panels, gas heating) have been replaced, excluding when the building was connected to a heating network;
5. Number of new social infrastructure buildings;
6. Number of social infrastructure buildings in which adaptation or renovation works were carried out (excluding thermal modernization works);
7. Area of revitalized brownfield sites (including post-industrial, post-railroad sites);
8. Length of renovated/constructed roads or paths designed for bicycle traffic;
9. Number of revitalized common spaces of an open character, such as courtyards, squares, promenades, river banks, and beaches, usually equipped with small architecture elements for recreation;
10. Number of renovated historic buildings;
11. Number of renovated residential historic buildings;
12. Number of renovated buildings without monument status;
13. Number of renovated residential buildings without monument status;
14. Number of buildings where work was carried out to improve their energy efficiency;
15. Number of buildings that have been adapted to the needs of people with disabilities;

Source: own elaboration based on: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica

The calculated levels of the synthetic measure of revitalization for each voivodeship are presented in Table 2. The highest level of the rank index was observed for the Lublin Voivodeship at (0.6612) in 2020 and the Silesian Voivodeship (0.6255) in 2021. In the period under review, the negative ideal voivodeship in terms of the scale of revitalization effects was found in the Opole Voivodeship, for which the synthetic index was (0.0341) and (0.0371), respectively.

Table 3. Ranking of self-government voivodeships in Poland based on the TOPSIS method

Voivodeship	*Pi*	*Ranking 2020*	*Pi*	*Ranking 2020*
Lower Silesia	0,2816	7	0,2310	10
Kuyavia-Pomerania	0,2116	10	0,3687	7
Lublin	0,6612	1	0,4332	4
Lubusz	0,2031	11	0,2014	13
Lodzkie	0,2689	8	0,3216	8
Lesser Poland	0,3178	5	0,4375	3
Masovia	0,2920	6	0,3958	5
Opole	0,0341	16	0,0371	16
Subcarpathia	0,1595	13	0,2018	12
Podlaskie	0,2139	9	0,2206	11
Pomerania	0,1674	12	0,2682	9
Silesia	0,3751	2	0,6255	1
Świętokrzyskie	0,3513	3	0,3711	6
Warmia-Masuria	0,0524	15	0,0513	15
Greater Poland	0,3342	4	0,4786	2
West Pomerania	0,1392	14	0,1635	14

Source: own elaboration based on: https://bdl.stat.gov.pl/bdl/dane/podgrup/tablica

Adopting the procedure (Wysocki 2010), it is possible to distinguish 4 typological classes of synthetic value based on the arithmetic mean and standard deviation. In 2020, the high level (group I) of revitalization effects occurred in the Lublin Voivodeship, and the average higher level (group II) was characteristic of 7 voivodeships. Slightly fewer (6) were characterized by the average lower level. In addition to the Opole Voivodeship, the Warmian-Masurian Voivodeship was also placed in Group IV. In the following period, the benchmark LGUs in Group 1 were the Silesian and Greater Poland Voivodeships. The average higher (group II) and average lower (group III) levels were observed in six voivodeships each. In the last group, the Warmian-Masurian and Opole Voivodeships were at a low level, as in 2020.

3.3. Discussion

In conclusion, considerations in the context of evaluating the revitalization process is an issue raised in the literature quite often. However, the choice of tools for the analysis of this process is different. When making decisions related to revitalization activities, multi-criteria methods are most often used, which, by means of ranking, allow comparative analysis of alternative projects (Bottero et al. 2018; Mayasari et al. 2018; Aigwi et al., 2019; Della Spina, Rugolo 2021). As noted by Chen et al. (2023), the adequacy of revitalization can also be assessed by using methods such as fuzzy evaluation, hierarchical analysis, or a hybrid genetic algorithm. However, the authors argue that these methods take into account the so-called output benefits and

propose the data envelopment analysis (DEA) as an alternative method to allow for obtaining more objective data. Research in this area was also conducted by Huan et al. (2016). Furthermore, as indicated by Wang et al. 2021, some authors developed new indicators to support decision-making processes in revitalization. In addition to this, revitalization measures were evaluated after their implementation usually through qualitative surveys among users of the spaces discussed. To evaluate revitalization activity, the authors used benchmarking analysis that highlighted best practices (Hlaváček et al.,2016).

The research carried out in this study uses multi-criteria methods such as TOPSIS and UTASTAR to evaluate the revitalization efforts undertaken by local government voivodeships in Poland. In conclusion, only Lesser Poland Voivodeship (for the most part) carried out revitalization activities based on the municipality revitalization program (GPR). Revitalization activities in LGUs relied on the transitional provisions in effect until the end of the current year.

Regarding the estimated funds allocated for revitalization, the clear leader was the Silesian Voivodeship. (However, in terms of the number of initiated projects in 2020 and 2021, it ranked second and seventh, respectively, among all voivodeships) The opposite situation was observed in Opole Voivodeship. In 2020-2021, the most frequently revitalized areas were the social sphere and the spatial-functional sphere. The highest number of revitalization activities was completed in 2020 by Lesser Poland Voivodeship (234 projects), and in 2021 by Kuyavian-Pomeranian Voivodeship (258 projects). The Lesser Poland Voivodeship also undertook the largest number of projects in the period studied (despite the fact that Kuyavian-Pomeranian Voivodeship completed the most projects in 2021).

4. Conclusions

The article examined the revitalization process of local government units using multi-criteria analysis methods. The literature review indicates that research based on such methods is used in evaluating the revitalization process, although the scope and focus of these studies vary. The research conducted fills a research gap in the evaluation of the revitalization process of local government voivodeships in Poland based on TOPSIS and UTASTAR methods. The methods used in the study made it possible to construct rankings that indicate the leaders i.e. the regions with the most intensified revitalization activities.

Based on the UTASTAR method, it can be concluded that the Greater Poland and Opole Voivodeships showed the highest and lowest revitalization activity, respectively. Based on the synthetic measure used in the TOPSIS method, Lublin and Silesian Voivodeships were the benchmark in terms of the number of revitalization effects achieved, while (as in the case of the UTASTAR method) Opole Voivodeship was the anti-benchmark. However, further research should be conducted regarding the adequacy of the achieved revitalization effects by analyzing the defined problems in degraded areas with the obtained results.

The study had a pilot character. The analysis conducted does not exhaustively cover the problems studied. Future research should include other types of local government units in a comparative framework, and the analysis should take into account the period before, during, and after the COVID-19 pandemic. The study could also be expanded to include the adequacy of the achieved revitalization effects.

Conflict of interest.
There is no conflict of interest.

Authors Contributions

The author/authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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