HOW THE ANALYTICAL HIERARCHICAL PROCESS AND REVITALISATION WORK TOGETHER: A CASE STUDY OF POLAND

Krzysztof Rogatka [1], Tomasz Starczewski [2], Mateusz Kowalski [3]

[1] Departament of Urban and Regional Development Studies, Nicolaus Copernicus University, Toruń, Poland
[2] Doctoral School of Social Sciences Academia Rerum Socialium, Nicolaus Copernicus University, Toruń, Poland
[3] Student Scientific Association "The Space Creators", Nicolaus Copernicus University, Toruń, Poland

Manuscript received: August 23, 2022
Revised version: November 6, 2022

Rogatka K., Starczewski T., Kowalski M., 2022. How the analytical hierarchical process and revitalisation work together: A case study of Poland. *Quaestiones Geographicae* 41(4), Bogucki Wydawnictwo Naukowe, Poznań, pp. 141–163. 1 fig., 7 tables.

Abstract: Due to the multifaceted nature of the revitalisation process, its evaluation and monitoring, as well as possible comparisons, are complex and difficult to carry out. Evaluation of the revitalisation process currently poses a challenge for all municipalities. The article aims to compare the revitalisation process in the two Polish cities of Toruń and Bydgoszcz. The analysis was based on two financial perspectives: 2007–2015 and 2016–2023. The authors chose a multi-criteria analysis method based on the analytical hierarchical process (AHP) as the main research method. The results show that the Local Revitalisation Programme of the City of Toruń for the years 2007–2015 had the best impact on the revitalisation process. Using the AHP method, we could carry out a multidimensional evaluation of the revitalisation process. Moreover, it allowed us to combine different elements of the evaluation of the revitalisation process and transform them into one synthetic result, ranking each programme in a hierarchy. At the methodological level, the article presents a new approach to conduct research in socio-economic geography, using the tool of multi-criteria analysis derived from the disciplines of economics and management sciences. Until now, the AHP method has not been used in the analysis of the revitalisation process, which confirms the innovative character of the conducted research.

Keywords: city, urban regeneration, evaluation, multi-criteria analysis, comparative analysis

Corresponding author: Tomasz Starczewski, Faculty of Earth Sciences and Spatial Management, Nicolaus Copernicus University in Toruń, 87-100 Toruń, ul. Lwowska 1, Poland; e-mail: t.starczewski@doktorant.umk.pl

Introduction and aim of the study

In the context of research undertaken in socio-economic geography, settlement geography and spatial economy, among others, the most important elements of a city are space, people and the environment (Lynch 1960). It can therefore be pointed out that the urban system as a whole consists of two main subsystems: physical and social. They are bound by mutual relations that can be defined based on communication theory (Mironowicz, Ossowicz 2005). According to this theory, spatial composition corresponds to a classical message, which consists of a sender (a

https://doi.org/10.14746/quageo-2022-0042
ISSN 2082-2103, eISSN 2081-6383

physical subsystem – the urban space sends a certain kind of message, which includes, among other things, the quality of the space, its appearance and structure) and a receiver (a social subsystem – a person receives stimuli from the space). The disruption of harmony between these elements leads to spatial and social degradation of the city (Clerci, Mironowicz 2009).

Degradation is the process of deterioration of land use. Research on urban degradation has defined four types of degradation: material, functional, moral and compositional (spatial). Material degradation refers primarily to matter, i.e. the poor technical condition of buildings and public spaces. Functional degradation occurs when there is a disruption in the functions that an area performs (Roberts et al. 2016). When a given community does not accept a given place and its image, we speak of moral degradation. On the other hand, compositional (spatial) degradation covers the degree of transformation of structures in the urban space. The process of degradation itself is a long-term and multifaceted phenomenon that emerged with the transformation of cities' formula from industrial to tertiary, when once vibrant industrial neighbourhoods became areas with a degraded urban fabric (Kostarczyk 2015). The answer to the degradation of urban structures lies in the revitalisation process, which is a coordinated mechanism aimed at bringing degraded areas out of crisis (Opoku, Boachie 2020). If we were to equate the city with an organism, revitalisation can be compared to administering medical care to a sick organism; this would involve an appropriate diagnosis and subsequent therapy with the application of remedial measures aimed at restoring the organism's health back to its original optimal condition, which, in the present case, would encompass the measures of structural, functional and social changes being implemented upon the city. (Kostarczyk 2015; Rogatka 2019).

The revitalisation process, like most processes occurring in urban space, has a specific goal or group of goals. In the case of the revitalisation process, we should discuss dimensions, i.e. levels of the process which determine the path of revitalisation activities. The five main dimensions of revitalisation include:

- the spatial and functional dimension, including the development of new functions for degraded areas. It also takes into account the creation of new spaces and the restoration of degraded areas that are spatially and functionally related to the same;
- the technical dimension, related to improving the quality of urban structures (e.g. technical infrastructure, roads, technical condition of buildings);
- the social dimension, referring to stopping negative social phenomena, such as pathologies, social exclusion and unemployment;
- the economic dimension, related to economic promotion of the revitalised area, supporting the entrepreneurship of the inhabitants, and creating new business entities and commercial undertakings;
- the environmental dimension, broadly understood as concerning improvement of the state of the natural environment, as well as elimination of pollution and various types of emissions (Poczobut 2009).

Revitalisation activities within the dimensions distinguished above can take three forms. The first of these is *ad hoc* land use, which involves adapting a degraded area, usually a building, to the needs of a particular community (Porter, Shaw 2013). These activities are carried out with very limited funds and investment activities. They are usually the first symptoms of the start of a revitalisation process (Adair et al. 1999). The second type of revitalisation activity is assimilation by the surroundings. It consists in developing the revitalised area so that it takes into account the functions and use of a neighbouring area or is a continuation of it. The third type is the revitalisation of a degraded area by introducing a new, spatially and functionally complementary investment (Czyżewska 2008). These activities are carried out through specific revitalisation projects which aim to bring the degraded area out of crisis, i.e. are in line with the objective of the revitalisation process (Manganelli et al. 2020).

The revitalisation process in a city is based on a local or communal revitalisation programme that integrates objectives, dimensions, activities and projects. It is a tool that allows for and initiates the transformation of the spatial and functional structure of a degraded area. A revitalisation programme is a strategic document defining the vision of the area after the revitalisation process (Acioly 2001). Thus, using legal nomenclature, revitalisation projects can be

called implementing acts of the revitalisation programme. The application of revitalisation projects is closely linked to the resources that a given city or commune may allocate to the revitalisation process. Revitalisation programmes, and therefore individual projects, can be financed from many sources. The primary ones include:

- EU funds, including regional operational programmes,
- government operational programmes,
- regional and local funds,
- the local budget,
- bank loans and bond issues,
- resources from the private sector, and
- public–private partnership (PPP) (Kopeć 2011).

After Poland's accession to the European Union, EU funds have played the most important role in financing the revitalisation process. They are the basis for revitalisation policy in Poland. Cities apply for EU funding within the framework of specific financial perspectives, which have different levels of funding and varying targets in different programming periods. Local authorities apply individually by submitting project applications (Sdino et al. 2020). The funds received are invested in various projects, activities and dimensions of the revitalisation process. The level of funding for individual projects in cities is not the same in each case. This depends on the purpose, nature and type of the project in question. Cities allocate EU funds in different ways based on endogenous resources, but above all on the revitalisation objective and the needs of the degraded area.

The study aims to compare the revitalisation process in Toruń and Bydgoszcz based on the contents of the respective revitalisation programmes using the analytical hierarchical process (AHP). The completed revitalisation process conducted on the basis of the revitalisation plan for the years 2007–2015 (first round) and the currently ongoing 2016–2023 period (second round) will be analysed. Therefore, the authors asked two research questions: (1) Which of the planning documents had the best impact on the revitalisation process in terms of multi-criteria decision-making? (2) Can the AHP method be used to monitor and evaluate the revitalisation process?

The research procedure was divided into three main stages. The first stage was conducted based on a literature study in the field of revitalisation, including articles and scientific monographs by Polish and foreign authors. It ended with the formulation of indicators needed to evaluate the revitalisation process in the light of the AHP methodology.

The second, main stage of the research involved an expert evaluation of the prepared indicators. The expert evaluation was carried out by five independent experts in the field of revitalisation; they analysed the indicators prepared on the basis of the revitalisation programmes and prioritised these indicators pairwise. The next step was comparative inference based on the AHP method. It involved analysing the revitalisation programmes of Toruń and Bydgoszcz in the light of the prepared evaluation indicators. The final, third stage of the research procedure was to draw up the research conclusions.

Polish context of revitalisation

The Polish experience of revitalisation is not as rich as the European one. This is due to Polish historical conditions. Until 1989, Poland was outside the European revitalisation discourse. Remaining under the influence of the USSR effectively inhibited the diffusion of revitalisation policies. During the communist years, Poland mainly developed the school of revalorisation of historical cities, which was limited to activities related to the conservation and repair of buildings of historical importance (Cęckiewicz 1989).

In the period after World War II, Poland focused on the reconstruction of war damage and the restoration of housing stock. The focus on the reconstruction alone led to the deterioration of older buildings that was accompanied by the incidence of negative social phenomena (Parysek 2015). The communist period saw an ever-growing renovation gap caused by the irrational management of housing stock by the communist authorities, deep poverty not only in villages but also in cities, and a lack of programmes for degraded areas. These elements, but also many others, caused a deepening social and spatial degradation (Jarczewski 2009; Muziol-Węcławowicz 2009). Of course, it should be noted that the communist period in Poland saw the rise of large-panel building. Uncontrolled,

it led to a disruption in the spatial order of cities, among other things. The systemic transformation which began in 1989 in Poland did not bring about any sudden changes in the approach to revitalisation—quite the contrary (Bury 2010). In typically industrial cities, spatial and social problems escalated due to the liquidation of state-owned enterprises. This fact was associated with the loss of many jobs, which in turn adversely affected socio-economic situation of the inhabitants (Lubecka 2010). The withdrawal of the Soviet Army from Poland caused another problem in the form of undeveloped military areas, which were gradually destroyed.

Despite the significant degradation of urban spaces and the poor social situation, the authorities would rarely decide to start revitalisation activities (Starczewski et al. 2022). This was due to the lack of statutory regulations for the organisation of the revitalisation process in cities and lack of financing possibilities. Milczyńska-Hajda (2009) distinguished six pioneer cities of Polish post-Soviet revitalisation (Szczecin, Bielsko-Biała, Sopot, Kraków, Płock and Lublin). Revitalisation activities in these cities were mainly carried out autonomously with the participation of foreign experts. Between 1992 and 1994, the first attempts were made in Poland to carry out pilot studies in the field of revitalisation, e.g. in the Kazimierz district of Krakow (Lorens 2016). The support of European and American financial institutions, such as the British Know How Fund or the USA ID programme, was an important element in the creation of a Polish revitalisation identity in the first years of free Poland. An impulse to build revitalisation policy based on regional policy was provided by the administrative reform in 1999. With the Act on the principles of supporting regional development and the National Strategy for Regional Development, the first attempts were made to build revitalisation programmes without assistance funds, based on regional resources (Skalski 2006). A milestone in revitalisation policy was Poland's accession to the European Union in 2004. Those Polish cities that were interested in revitalising their areas were given the opportunity to finance projects from EU funds. Between 2004 and 2006, as many as 167 local revitalisation programmes were drawn up, of which 113 formed the basis for applying for European funding (Domański 2009). Today, revitalisation is a common process in Polish cities, and is carried out using various instruments and financial frameworks.

An area can be brought out of crisis adopting different methods and taking various actions. Markowski (1999) distinguished at least four different types of approaches to planning the process of transforming urban structures. The first type is attraction planning, which involves the creation of attractive conditions for investors and usually brings about the economic development of a given unit. The second type is impactive (reactive) planning. This is the opposite of attraction planning. This approach implies a passive policy on the part of municipal authorities until crises occur. Such planning includes elimination and mitigation of negative impacts. The third type of planning is surprise planning (i.e. planning under unpredictable events). It involves accepting the unpredictability of the development of a given area and preparing scenarios in the event of a specific threat or negative phenomenon. The last type of planning activities distinguished by Markowski is strategic planning, involving the adoption of a long-term and long-range vision of the development of a given area, on the basis of which decisions will be taken to implement the vision contained in the strategy.

In the context of the revitalisation process, the strategic planning approach is most appropriate. It is the only one that can help formulate a vision of the degraded area after the revitalisation process and take actions relevant for the type of negative phenomena occurring in that area. Strategic planning requires significant financial resources, which burdens and strains the budgets of territorial units. According to Lorens (2000), four models of financing revitalisation projects have emerged in the revitalisation space.

The first model involves direct funding from local or supra-local government budgets. This model is used for the implementation of projects that are crucial for further revitalisation measures (mainly infrastructure investments). The application of such a model may be limited by a local budget that is too low or the lack of a long-term development vision determining the commune's planned expenditures. The second and most desirable model of financing revitalisation programmes is the PPP, in which a private party finances the implementation of a revitalisation

project and the public party pays a remuneration for such an action. In the PPP model approach, the private entity assumes responsibility for the entire revitalisation project, i.e. its construction, operation, management and monitoring (Herbst 2009). Owing to the private and public partners typically having different objectives and varying degrees of involvement, it is possible to distinguish several PPP models. (Sobiech 2007). From the viewpoint of the benefits for the public sector, the best PPP models are those in which the private party finances most (if not all) of the project.

In addition to the PPP and direct financing model, Lorens (2016) distinguished the special regulation zone model, which involves the creation of legal conditions that give areas a special tax or planning status. This model is used for long-term projects and creates opportunities to attract potential investors, due to favourable legal conditions (Czyżewska 2003). The last model of financing involves the creation of technical and professional assistance programmes, in which an informed group of investors (private and public) employing appropriate professionals is ready to finance interdependent and complementary projects.

In addition to the financing models for revitalisation presented above, European Union funds play the most important role. They are the catalyst for most changes in the space of Polish and European cities. Since Poland became an EU member state, EU funds have become the basis for financing projects and revitalisation programmes. The first instrument after Poland's accession was the Integrated Regional Development Operational Programme for the years 2004–2006 (Dziurbejko 2006). This programme aimed to increase the competitiveness of the regions and to reduce the marginalisation of areas. The revitalisation activities within the above-mentioned programme were concentrated around the third priority, which included local development. In the next perspective, 2007–2013, financing for revitalisation measures could be obtained from the European Regional Development Fund, whose resources were guaranteed in the Regional Operational Programmes of individual voivodeships (Lubińska et al. 2007). Funds for revitalisation could also be obtained in the 2014–2020 financial perspective. Local governments can find them in the 'Infrastructure and Environment' programme, priority axis II: environmental protection, including adaptation to climate change, measure 6.5. The very name of the axis indicates a strong emphasis on carrying out revitalisation measures taking into account all pro-environmental solutions as part of the eco-development policy. Wilkosz-Mamcarczyk (2018) mentions some examples of such measures, including the use of vegetation in the revitalisation of post-industrial areas: the Ruhr and the Upper Silesian Industrial District. Further examples of revitalisation strongly linked to the natural environment are the multidimensional remedial actions carried out on riverbanks (Nawieśniak-Caesar et al. 2019), or the development of so-called 'green urbanisation' through the investment in green urban spaces, namely parks, squares, etc., both existing and new ones (Sosnova, Wilkosz-Mamcarczyk 2017).

Materials and research methods

We assessed the revitalisation process in Toruń and Bydgoszcz carried out based on revitalisation programmes in the light of two financial perspectives. The cities that are co-capitals of the Kujawsko-Pomorskie Voivodeship are good examples of revitalisation activities, as this process has been continued in the space of Toruń and Bydgoszcz for many years. The analysis included four revitalisation programmes, two each for the past and current programming periods. Table 1 provides details of the documents that form the basis for the considerations undertaken.

The analysis of the revitalisation process focuses on the revitalisation areas designated in the programmes, which are the focus of revitalisation activities in the city. As part of the revitalisation activities for 2007–2015, two revitalisation areas were designated in Toruń: Old Town and Bydgoskie Przedmieście. The area selected for housing-related revitalisation was Old Town. The total number of inhabitants included in the revitalisation process was 37,650, while the revitalisation area was 6.21 km^2. In the same period, four areas were revitalised in Bydgoszcz: Śródmieście, Wyżyny, Kapuściska and Leśne. The last three were identified as areas of housing intervention. The revitalisation area was 9.93 km^2, inhabited by 88,205 people.

Table 1. Revitalisation documents analysed.

City	Name of revitalisation programme	Legal basis	Date of last amendment	Programming range
Toruń	Local Revitalisation Programme of the City of Toruń for the years 2007–2015 (LRP Toruń)	Resolution No. 624/09 of the City Council of Toruń of 29 August 2009	Nov 13, 2014	2007–2015
Toruń	Toruń Revitalisation Programme until 2023 (RP Toruń)	Resolution No. 922/18 of the City Council of Toruń of 6 September 2018	Feb 2, 2020	2016–2023
Bydgoszcz	Local Revitalisation Programme of the City of Bydgoszcz for the years 2007–2015 (LRP Bydgoszcz)	Resolution No. XLIX/728/09 of the City Council of Bydgoszcz of 24 June 2009	Sept 23, 2015	2007–2015
Bydgoszcz	Communal Revitalisation Programme of the City of Bydgoszcz for 2023 and thereafter (CRP Bydgoszcz)	Resolution No. IV/12/18 of the City Council of Bydgoszcz of 28 November 2018	–	2016–2023

Source: own elaboration.

Within the perspective until 2023, three areas were designated for revitalisation in Toruń. Old Town and Bydgoskie Przedmieście were joined by Podgórz located on the left bank of the Vistula river. The revitalisation area has increased in size and is now 17.69 km^2 with a population of 42,703. Bydgoszcz has also extended its revitalisation area. It covers an area of 16.76 km^2 and is inhabited by 53,520 people. In Bydgoszcz, the areas identified for revitalisation in the current programme are the following structural units: (1) Bocianowo-Śródmieście-Stare Miasto, Okole and Wilczak-Jary; (2) Stary Fordon; and (3) Zimne Wody-Czersko Polskie. Figure 1 shows the spatial extent of revitalisation areas within each programming period.

To achieve the aim of the study, four research methods were used in the course of the analyses:
- desk research,
- case study,

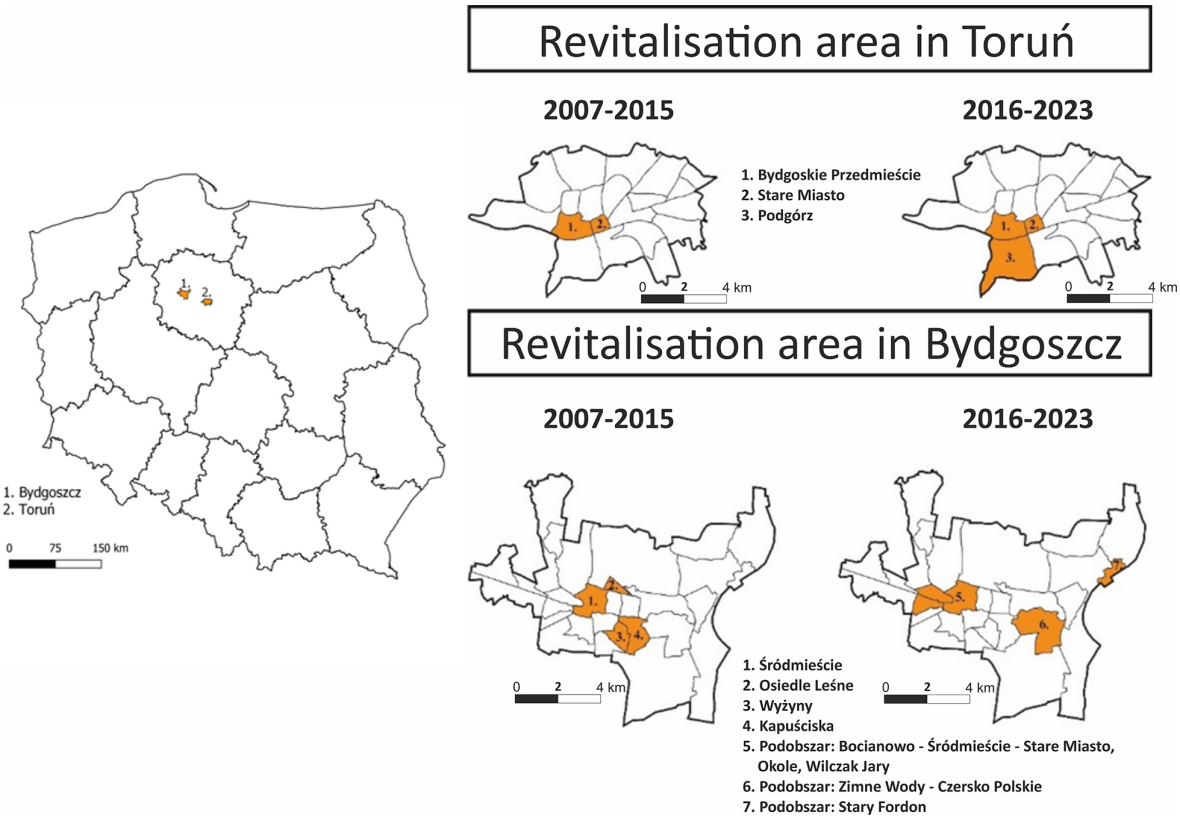

Fig. 1. Spatial scope of the study – Revitalisation areas of Toruń and Bydgoszcz.
Source: own elaboration.

- AHP method, and
- comparative study.

The desk research method includes the analysis of existing, secondary materials, i.e. programmes, strategies, plans and legal acts, as well as literature (Makowska 2012). It should be pointed out that the desk research method cannot be equated with a scientific literature review (Kiecolt et al. 1985). Many advantages of using the desk research method can be seen in the literature. Authors list the following:

- analyses are easily accessible and do not incur high costs (Hoofferth 2005),
- they enable a researcher to analyse data from different sources, on many different samples (if the range of data analysed allows it) (Heaton 2008), and
- a researcher has no influence on the subject of the study, and the possibility of data manipulation is relatively low (Babbie 2003).

Bednarowska (2015) distinguished two types of desk research: primary and auxiliary. Primary desk research can be a specific, individual research project that does not use or refer to primary data. It serves as a testing ground to identify the topic and verify subsequent research assumptions. Auxiliary desk research covers the primary understanding of the research topic. This type cannot be the basis of a project and additional methods should be used during the research to verify theses and assumptions. Primary desk research was used in the context of this study. The research is based on the analysis of existing materials, in this case the revitalisation programmes of Toruń and Bydgoszcz.

The second research method used was the case study method. It involves analysing a specific case based on its detailed description. This description allows the researcher to draw conclusions, establish a cause-effect chain, notice dependencies and make comparisons of the phenomenon under study (Pietrzak, Baran 2007). The case study method is mainly used by scholars in the fields of economics, law and business, but is increasingly being translated for use in urban studies (Yin 2003). The history of the method began in the United States at the turn of the 20th century. Its first use is attributed to Harvard Business School, through which the method spread to business schools in the USA and Western Europe (Eisenhardt 1989). The case study is a qualitative research method that allows the context and nature of the phenomenon under study to be determined. In this paper, the case study analysis included:

- preliminary identification of the revitalisation ground based on revitalisation documents;
- analysis of the revitalisation documents, with particular emphasis on the characteristics of degraded areas, and the indicators used for the delimitation of the degraded area and for the monitoring of the process itself; and
- a comparative analysis of revitalisation documents between Toruń and Bydgoszcz and between the two perspectives – previous and present.

The third method used was the AHP method. It is one of the most popular multi-criteria analysis methods (Gao, Hailu 2013). It is used in many different studies, from many different fields. The AHP is an extension of another multi-criteria analysis method – analytic network process (ANP). Both of these methods were developed by the American researcher Thomas L. Saaty in the 1970s. The idea behind the AHP method is to support decision-making in complex processes with multi-criteria analysis (Saaty 2008). In the AHP method, the main principle is to evaluate a given decision problem in the light of a number of different evaluation criteria. It is used in the analysis of complex decision problems that are influenced by many factors. It allows a researcher to make comparisons of the selected decision options, and thereby evaluate which among these best meets the assumed evaluation criteria. The process of revitalising urban spaces is a complex one that is influenced by many factors. The complexity of the revitalisation process determines the complexity of the subsequent evaluation of the process. Using the AHP method, multiple evaluation criteria can be compared with each other. Subsequent mathematical verification helps identify differences between decision options—in the context of this paper, differences between prospects and revitalisation programmes.

Results

In the AHP method, it is crucial to maintain the transparency of the comparisons made, the decision options and the evaluation criteria.

These need to be described and explained so that the subsequent analysis is free of theoretical inaccuracies (Prusak, Stefanów 2014). The first step, which was presented in the earlier subsection, is to characterise the different decision options on the basis of which the AHP method will be carried out. In this method, they are the basis for the formulation of the decision problem. In the case of this work, the problem is the analysis of the revitalisation process on the basis of revitalisation programmes and their provisions. Another important step in the AHP method is the description of criteria according to which the decision options—revitalisation programmes—will be evaluated. The evaluation criteria are one of the most important elements of the whole procedure, as they determine the further results and impart character to the study (Goodwin, Wright 2011).

Our research distinguished five evaluation criteria for each of the decision options. These criteria were related to different levels of the revitalisation process and illustrated how revitalisation was carried out in each of the two cities studied. The first criterion used was the number of indicators used to delimit the revitalisation area. The greater the number of indicators used, the more in-depth and complete the analysis of the crisis state will be. The use of multiple, thematically diverse indicators allows for an in-depth characterisation of the city and individual structural units. Carrying out a broad delimitation of a degraded area provides information about its needs that revitalisation projects should address.

The second evaluation criterion used was project value per inhabitant of the revitalisation area. It is understood as the sum of financial outlays under the revitalisation programme per one inhabitant of the revitalisation area, i.e. an area that is subject to revitalisation changes. Owing to the use of such a criterion, we can notice differences in the level of financing of the revitalisation programmes. Ultimately, the value of a single project should be as high as possible, which would indicate the high capital intensity of the process. Going further, the high project value per capita speaks for the fact that the city as an institution managing the revitalisation process is aware of the negative phenomena in the revitalisation area and invests significant financial resources there.

Another evaluation criterion analysed is the share of projects submitted by non-municipal entities in the total number of revitalisation projects. This criterion is extremely important from the point of view of public participation during the revitalisation process. The entire process should be, and is, led by stakeholders that in accordance with the Revitalisation Act include municipal entities, such as the municipal office or the municipal family assistance centre. However, the stakeholders of the revitalisation process are not only the budgetary entities, but first and foremost the inhabitants who live in the area that is subject to revitalisation transformations. It is important that their participation is visible and appreciated (Szlachetko, Szlachetko 2019). Analysing such a criterion, one can indicate how the city's revitalisation policy is conducted, i.e. whether it is dominated by projects submitted by public institutions or private entities representing the needs of the local community. Of course, according to the concept of social inclusion, in properly conducted strategic planning processes, public participation should be as high as possible (Jakubczyk, Kitowski 2015).

The process of monitoring revitalisation is one of the greatest challenges of Polish and global revitalisation policy. Therefore, the next two evaluation criteria concern the monitoring carried out by the analysed cities. The number of monitored revitalisation areas in relation to the total number of revitalised areas was one of the two indicators that pertained to the monitoring of the revitalisation process. In each of the perspectives analysed, there are revitalisation areas that are designated for housing activities. The above-mentioned criterion is constructed so as to indicate whether all revitalisation areas are subject to monitoring, including the area related to housing.

The last criterion used to evaluate revitalisation programmes was the number of indicators used to monitor the revitalisation process. Monitoring of revitalisation should be conducted continuously in a manner specified by the revitalisation programme. In its scope, it should first of all include a diagnosis of how the objectives and targets of revitalisation are implemented. Monitoring based on a wide range of indicators allows for in-depth analysis of the revitalisation changes taking place. The use of a number of indicators also makes it possible to detect possible gaps in the activities carried out, to verify the projects implemented and to carry out a comparative

analysis between the initial state and the current one (Jarczewski, Jeżak 2010).

The evaluation criteria discussed above take up the most important elements of the revitalisation process, i.e. the diagnosis of the crisis state (the number of indicators used for delimitation), financing of revitalisation (project value per one inhabitant of the revitalisation area), social participation (the share of projects submitted by non-municipal entities) and monitoring (the number of areas covered by monitoring and the number of indicators used for monitoring revitalisation). The selection of such evaluation criteria allowed us to synthesise the evaluation of the thematically extensive process of revitalisation into five thematically coherent evaluation criteria.

The next step in the AHP procedure is to describe revitalisation programmes according to the evaluation criteria prepared and discussed earlier. Next to constructing the evaluation criteria, this step is another important element in the AHP method. It is on the basis of the prepared data matrix that pairwise comparisons of individual revitalisation programmes will be made. The characteristics of individual revitalisation programmes based on the evaluation criteria are presented in Table 2.

Based on Table 2, we can already identify differences in the way the revitalisation process was conducted in different cities and perspectives. Analysing the first criterion, it can be concluded that in the first revitalisation programming period (2007–2015), cities used more indicators to delimit the revitalisation area. In the second perspective until 2023, the number of indicators used has decreased and is the same in each city. The city of Bydgoszcz used the most indicators for delimitation in the first revitalisation programme analysed.

Funding for revitalisation varies between perspectives and cities. In the case of Toruń, more funds per capita in the revitalisation area were allocated in the first programming period than in the second. The difference is around PLN 1,000 per inhabitant. This may be due to the fact that in the second perspective, another revitalisation area was added and the funds were not divided between two structural units but among three. In the case of Bydgoszcz, the situation is radically different. It was in the second programming period that almost three times more funds were allocated per inhabitant of the revitalisation area, with the figure exceeding PLN 6,000.

The analyses carried out show that the proportion of projects submitted by non-municipal entities in Toruń has been decreasing. Under the first perspective, this was >60% of applications, whereas in the current perspective, this is <50%. This demonstrates a negative trend in the approach to revitalisation in Toruń. Increasing the number of projects submitted by municipal entities is unfavourable from the point of view of

Table 2. Description of the revitalisation programmes according to the evaluation criteria.

Revitalisation programme	Number of indicators used to delimit revitalisation area	Project value per one inhabitant of revitalisation area	Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects (%)	Number of monitored areas in relation to total number of areas (%)	Number of indicators used to monitor revitalisation process
Local Revitalisation Programme of the City of Toruń for the years 2007–2015	6	PLN 3,150.71	64.86	100	10
Communal Revitalisation Programme of Toruń until 2023	5	PLN 2,121.05	43.08	100	4
Local Revitalisation Programme of the City of Bydgoszcz for the years 2007–2015 (LRP Bydgoszcz)	10	PLN 2,266.81	50.00	100	5
Communal Revitalisation Programme of the City of Bydgoszcz for 2023 and thereafter (CRP Bydgoszcz)	5	PLN 6,079.47	69.84	100	5

Source: own elaboration.

involving stakeholders in the revitalisation process. The situation in Bydgoszcz is quite the opposite. Almost 70% of applications in the current revitalisation perspective were submitted by entities other than municipal ones. This is an increase in relation to the 2007–2015 perspective of almost 20%. This shows that revitalisation in Bydgoszcz is carried out mainly based on projects of inhabitants and entities representing them. Municipal interference is limited to only 30% of the projects submitted.

It is extremely pleasing that both cities in both perspectives monitor all revitalisation areas, including the area with housing interventions. This is a very good sign that the monitoring of revitalisation is understood by Toruń and Bydgoszcz as a comprehensive process covering all revitalisation activities. The situation with the indicators used to monitor the revitalisation process is less positive. In Toruń, there has been a negative trend, with the number of indicators used falling by more than half. In the first perspective, monitoring was carried out on the basis of 10 indicators, while in the current perspective it is based on four indicators only. Reducing the number of indicators may lead to selective monitoring of revitalisation only in selected fields. Revitalisation should be understood holistically and therefore delimitation and monitoring indicators should be formulated and analysed as broadly as possible (Roberts, Sykes 2006). In Bydgoszcz, the number of indicators used for monitoring revitalisation in both perspectives is at the same level.

Formulating a description of the decision-making programmes based on the evaluation criteria does not facilitate the researcher to unequivocally ascertain which of the revitalisation programmes is better by way of being more responsive to the analysed criteria. The description of the criteria made in this way serves as a basis for ascertaining an indicative level of solution to the decision problem. This is later refined at the stage of the actual AHP analysis (Peng 2012).

In order to be able to start a comparative analysis using the AHP method, an expert evaluation of the prepared evaluation criteria must first be carried out. Six revitalisation experts evaluated the criteria in pairs on a one-to-one basis. The experts rated the pairs on the basis of superiority, i.e. whether criterion A or criterion B is more important in the context of evaluating the revitalisation process and to what extent. The evaluations were carried out using Saaty's 9-point pairwise comparison scale. They were then aggregated by arithmetic mean to a single value for each pair of

Table 3. Pairwise comparison matrix of evaluation criteria.

Indicator	Number of indicators used to delimit revitalisation area	Project value per one inhabitant of revitalisation area	Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	Number of monitored areas in relation to total number of areas	Number of indicators used to monitor revitalisation process
Number of indicators used to delimit revitalisation area	1	5	7	4	1
Project value per one inhabitant of revitalisation area	1/5	1	4	3	1/5
Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	1/7	1/4	1	1/4	1/8
Number of monitored areas in relation to total number of areas	1/4	1/3	4	1	1/4
Number of indicators used to monitor revitalisation process	1	5	8	4	1
Total	2.59	11.58	24.00	12.25	2.58

Source: own elaboration.

comparisons. In this way, the first matrix of pairwise comparisons of the evaluation criteria was prepared, and it is presented in Table 3.

Once the matrix of pairwise comparisons has been made, the next step in the AHP method is to determine the significance (weight) of each evaluation criterion. This is done through a number of methods. In the literature, researchers use geometric mean methods, arithmetic mean methods or matrix multiplication methods to determine the weight of criteria. The arithmetic mean method was used in this study. The weighting of each criterion is done in stages. The first step is to normalise the elements of the pairwise comparison matrix. This is done by calculating the sum of the values of all the columns and then dividing each value of a column by the sum of the values of the whole column. The results of the normalisation of the data presented in Table 4 are given below. Once the matrix values have been normalised, the arithmetic mean should be calculated for each row of the normalised data—this is the second and final step in determining the weighting of the evaluation criteria. The resulting values can be represented as a decimal fraction or as a percentage.

In terms of the weights of the criteria, the experts deemed the number of indicators used to delimit and monitor the revitalisation area as the most important criteria for evaluation of the revitalisation process. Next in line is the level of project funding per capita. The least important from the point of view of the revitalisation process are: the number of areas covered by monitoring and the share of projects submitted by non-municipal entities.

Once the evaluation criteria have been weighted, it is necessary to examine whether the matrix of pairwise comparisons made by the experts is consistent, i.e. whether the results obtained above can be used in the further stages of the study. The matrix consistency verification process is carried out based on four steps.

Step 1. Determination of the largest eigenvalue of the matrix under analysis (λ_{max}).

The largest eigenvalue of a matrix based on the arithmetic mean method is determined in two phases. The first of these is matrix calculation. The values of the input matrix (Table 3) are multiplied by the vector of weight coefficients (weight column, Table 4). The value of the matrix for the data presented above is as follows:

Table 4. Normalised matrix values and weighting of the evaluation criteria.

Indicator	Number of indicators used to delimit revitalisation area	Project value per one inhabitant of revitalisation area	Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	Number of monitored areas in relation to total number of areas	Number of indicators used to monitor revitalisation process	Weight
Number of indicators used to delimit revitalisation area	0.39	0.43	0.29	0.33	0.39	0.36
Project value per one inhabitant of revitalisation area	0.08	0.09	0.17	0.24	0.08	0.13
Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	0.06	0.02	0.04	0.02	0.05	0.04
Number of monitored areas in relation to total number of areas	0.10	0.03	0.17	0.08	0.10	0.09
Number of indicators used to monitor revitalisation process	0.39	0.43	0.33	0.33	0.39	0.37

Source: own elaboration.

$$\begin{bmatrix} 1 & 5 & 7 & 4 & 1 \\ 1/5 & 1 & 4 & 3 & 1/5 \\ 1/7 & 1/4 & 1 & 1/4 & 1/8 \\ 1/4 & 1/3 & 4 & 1 & 1/4 \\ 1 & 5 & 8 & 4 & 1 \end{bmatrix} \times \begin{bmatrix} 0.36 \\ 0.13 \\ 0.04 \\ 0.09 \\ 0.37 \end{bmatrix} = \begin{bmatrix} 2.03 \\ 0.71 \\ 0.19 \\ 0.47 \\ 2.07 \end{bmatrix}$$

Then we need to divide each of the results of the matrix calculation by the value of the weighting factor. This is done according to the following formula:

$$\frac{\text{Result of the matrix calculus}}{\text{Matrix vector}} = \text{Eigenvector of the matrix}$$

The results of the matrix eigenvectors are shown in Table 5.

Having calculated the eigenvectors of the matrix, one can proceed to the second phase, i.e. estimating the largest eigenvalue of the matrix. It is determined by the following formula:

$$\lambda_{max} = \frac{\sum_{i=1}^{n} \lambda_i}{n}$$

and therefore:

$$\lambda_{max} = \frac{5.56 + 5.44 + 5.14 + 5.01 + 5.54}{5} = 5.34$$

Thus, if λ_{max} is:

- equal to n, then the matrix is fully consistent;
- slightly greater than n, then the matrix is slightly inconsistent, and the results can be used for further steps;
- much larger than n, then the matrix is inconsistent and the results of the analysis should not be used for the further stages of research.

Calculating the largest eigenvalue of a matrix alone does not guarantee a 100% consistent matrix. For this purpose, further steps of formal verification of the matrix are carried out.

Step 2. Determination of the matrix consistency index (CI).

The matrix CI is determined by the following formula:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

Thus, the value of the CI of the analyses carried out is as follows:

$$CI = \frac{5.34 - 5}{4} = 0.085$$

Step 3. Determination of the matrix consistency ratio (CR).

The CR of the matrix is determined by the following formula:

$$CR = \frac{CI}{RI}$$

where CI indicates the matrix CI, and RI a tabulated quantity dependent on the number of elements being compared.

Thus, the CR of the matrix of the analyses performed equals:

$$CR = \frac{0.085}{1.11} = 0.076$$

Step 4. Interpretation of the matrix CR.

If the resulting matrix CR value is ≤0.10 (the critical value indicated by Saaty 2004), then pairwise comparisons have been performed correctly, the matrix is consistent and decisions based on the results will be well-founded. If the CR value is >0.10, the pairwise assessment procedure

Table 5. Eigenvectors of the matrix for the evaluation criteria.

Criterion	Number of indicators used to delimit revitalisation area	Project value per one inhabitant of revitalisation area	Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	Number of monitored areas in relation to total number of areas	Number of indicators used to monitor revitalisation process
Eigenvector of matrix	5.56	5.44	5.14	5.01	5.54

Source: own elaboration.

and the other four verification steps should be repeated.

As a result of such analyses, it can be concluded that the pairwise comparisons of the evaluation criteria made by the experts are appropriate, the matrix is consistent and one can proceed to the next steps of the AHP method.

Once the matrix CR is positive, we can proceed to pairwise comparisons of all individual decision options and each of the pairwise evaluation criteria separately. The procedure is identical to the one described earlier, with the difference that the decision options—revitalisation programmes—are compared with each other and not with individual criteria. The results for each of the evaluation criteria are presented in the Appendix.

Using the calculations contained in the Appendix, we were able to verify that each of the matrices for individual criteria is consistent, and thus the results of the analyses can be applied in establishing the final ranking and selection of the best decision option—revitalisation programme. For this purpose, the values of weights calculated for particular criteria in relation to particular revitalisation programmes and the weight of the criteria calculated at the beginning of the procedure (column 'Weight', Table 4) should be tabulated. The input matrix for the final matrix is shown in Table 6.

Once the data matrix has been prepared, we move on to the next steps in implementing the AHP method. For this purpose, a matrix calculation should be performed between the value of all criteria for each of the revitalisation programmes and the established weight of a given criterion.

Table 7. Ranking of revitalisation programmes.

Rank	Programme	Value
I	LRP Toruń 2007–2015	0.37
II	LRP Bydgoszcz 2007–2015	0.32
III	CRP Bydgoszcz 2016–2023	0.21
IV	RP Toruń 2016–2023	0.10

Source: own elaboration.

The highest value in the matrix indicates the best solution in terms of decision-making—in the case of this study, the best revitalisation programme from the point of view of the decision-making options adopted. The matrix values are presented in Table 7.

According to the AHP method and in the light of the evaluation criteria adopted, the best revitalisation programme on which revitalisation activities were based is the Local Revitalisation Programme of the City of Toruń for the years 2007–2015.

Discussion

Due to its versatile nature, the AHP method can be used in many scientific fields. For example, the government of Turkey applied it to select the best reconstruction option for a city following the catastrophic earthquake of 17 August 1999. As a result of the disaster, the town of Adapazari, located in the north-west of the country, was destroyed (Çil, Arman 2001). In the course of proceeding with the AHP method, the optimal urban reconstruction model matching the current socio-economic situation was selected. Thus, the authorities were able to combine a number

Table 6. Input data matrix for the final matrix.

Revitalisation programme	Number of indicators used to delimit revitalisation area	Project value per one inhabitant of revitalisation area	Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	Number of monitored areas in relation to total number of areas	Number of indicators used to monitor revitalisation process
Toruń 2007–2015	0.15	0.22	0.29	0.25	0.58
Toruń 2016–2023	0.09	0.08	0.07	0.25	0.09
Bydgoszcz 2007–2015	0.66	0.05	0.13	0.25	0.16
Bydgoszcz 2016–2023	0.09	0.64	0.51	0.25	0.16
WEIGHT criterion	0.36	0.13	0.04	0.09	0.37

Source: own elaboration.

of criteria influencing the selection of a new city location. The method was also employed to improve the performance of the AS/400 computer designed by IBM (Saaty 2004; Ogrodnik 2014). Multi-criteria decision-making using the AHP method has also found application in the introduction of innovations to passenger transport. In 1998, British Airways used it to select the provider of the entertainment system for passengers travelling on their airline. The method has also gained international acceptance in the settlement of international disputes. The AHP was used to settle a conflict between the USA and China in an intellectual property rights battle in 1995. This dispute involved the illegal copying of music, video and software tapes and CDs by the Chinese side. The US side's AHP analysis included three criteria: benefits, costs and risks, and showed that the better option was to abandon US sanctions on China (Saaty 2008).

The AHP method thus allows for the individual preparation of evaluation criteria directly related to a given situation, process or individual case, which is why it has gained acceptance in international relations, economics, management and quality sciences, and spatial planning, among other disciplines (Solangi et al. 2021). In the context of this research, the AHP method was utilised for the first time to evaluate a revitalisation process. The implementation of the method into urban research should be considered pioneering and successful, as evidenced by the conclusions presented in this article.

The revitalisation process can be evaluated using quantitative research methods, as presented in this paper. However, it should be borne in mind that in order to optimise the results of quantitative research, qualitative research (such as individual in-depth interviews and participatory observation) should be carried out as complementary procedures, e.g. among residents or users of the revitalisation space. Bury (2010) suggests that in qualitative research, the questionnaire should be structured in such a way that the answers given are binary in nature, which facilitates the subsequent interpretation of the results and helps draw detailed and interesting conclusions about the perception of the post-revitalisation space (Bury 2010). Elsewhere, Hermawan et al. (2019) propose the use of participatory observation in the revitalisation area, which allows for the study of groups and the processes taking place in their natural environment. This opens up a completely different, holistic, and thus broader, contextual research perspective on revitalisation.

Performing quantitative and qualitative research in synergy allows for a comprehensive evaluation of the revitalisation process. This triangulation of methods yields comprehensive results that will help revitalisation measures to be better tailored to the needs of local communities. The results thus obtained relate to an important social layer of the process. The essence of the revitalisation process is precisely to respond to the needs of the local communities of the area being revitalised. In the context of the above, the authors recommend a hybridised methodology for studying, monitoring and evaluating the process.

The authors analysed the strengths and weaknesses of the study. The strengths of the study conducted and the method used certainly include the ease of access to data and the versatility of the AHP method. The data used in the study are publicly available in the LRPs and CRPs of the various cities and posted on websites. Among the strengths of the AHP method itself are its high versatility and its application in various fields of life (management, sociology, transport, logistics and IT, among others). Furthermore, a decision-making process based on this method has long been successfully applied in practical operations and is very popular with decision-makers in both private and public sectors. The main advantages of the method include, first of all, the possibility of looking at the decision problem from a different perspective by arranging the criteria and options in a hierarchy and eliminating the risk of bias or manipulation influencing the decision. Furthermore, an advantage of the AHP is that the method can easily be combined with, for example, a survey or individual depth interview (IDI), complementing and broadening the research perspective at the same time.

On the other hand, the undoubted limitations of the study and method include the processing of data on a desk research basis and a certain degree of subjectivity of the AHP method. The development of the tables with the data records used in the study was carried out based on desk research, i.e. extracting information of interest to the researchers from the revitalisation programmes (LRP and CRP). This required tracing entire

studies in order to capture the necessary information. At this point, it should be mentioned that the documents analysed have been amended and revised several times. It was challenging for the researchers to get to the most up-to-date documents that reflected the reality of the revitalisation process under way. As far as the limitations of the method are concerned, the main drawbacks of the AHP include the discretionary nature of the final rankings linked to the subjectivity of individual assessments, and the use of a conventional rating scale. The use of Saaty's 9-degree scale is intended to minimise the relative discretion of the research, but individual criteria are assessed by a panel of experts. In this situation, the human factor will be the limiting factor of the study. Although experts assess projects based on an objectified scale, the ratings reflect their subjective feeling. Therefore, the method prepares a mathematical verification of the expert assessments, which compensates for errors therein.

Conclusions

When analysing the description of the decision options, it is important to focus on the differences that emerged between the cities and between the different financial perspectives. LRP Toruń is the only one to include references to all levels of strategic documents. There is a similarity in the approach to formulating a revitalisation programme between RP Toruń and LRP Bydgoszcz. In these documents, reference was found only to regional and local level documents. CRP Bydgoszcz has almost full reference to strategic documents (no reference to European documents). Most of the revitalisation programmes analysed contained provisions relating to the mission and objectives of revitalisation. This is a welcome fact, as the revitalisation process should be conducted based on a coherent vision of the area, taking into account current needs diagnosed at the stage of delimitation of the degraded area. Turning to the delimitation criteria included in the analysed programmes, it should be pointed out that in the 2016–2023 perspective both cities used the same number of indicators. This may indicate that the revitalisation process, which was carried out on the basis of the above financial framework, was more structured. In the case of the previous financial perspective, the number of indicators was not strictly defined, which resulted in a certain freedom in their selection (Toruń 6, Bydgoszcz 10). This is confirmed by the fact that in the 2016–2023 perspective, both Toruń and Bydgoszcz used the same method of delimiting the degraded area, involving establishing the value of indicators based on a value above the average for the city. Different methods were used in the previous perspective (statistical standardisation of criteria, summary index and valuation of percentage deviations of indicators). The financing of revitalisation carried out in both cities in both perspectives included the municipality's own funds, EU funds and private funds. Unfortunately, none of the analysed programmes included the model of PPP, which is one of the most beneficial models from the revitalisation point of view. The revitalisation process conducted on the basis of the programmes is most often monitored once a year. Monitoring structures are more developed in the second financial perspective in both cities.

The interpretation of the results yielded by the AHP method should be divided into two stages. The first stage involves the analysis of global priorities (weights set for individual evaluation criteria) and local priorities (weights of individual criteria set for decision options). In terms of global priorities, the most important criteria include the number of indicators used to delimit the degraded area and monitor the revitalisation process. These indicators received the highest weights in the matrix procedure, and these weights are very close. This shows that the experts who evaluated the criteria in pairs considered that delimitation and monitoring were the most important criteria against which revitalisation should be assessed in this study. A well-conducted diagnosis of the revitalisation area, based on individual and detailed indicators, allows above all for a more in-depth identification of problems occurring in a given area as well as an indication of the strengths and weaknesses of structural units.

In terms of local priorities, LRP Toruń achieved the highest value for the criterion relating to the number of indicators used to monitor the revitalisation process. Toruń's second revitalisation perspective did not achieve high values for the weights of the individual criteria. This demonstrates the low importance of this perspective in the comparative analyses conducted, which was

confirmed by the final procedure in the AHP method. LRP Bydgoszcz had the highest weight of the criterion concerning the number of indicators used to delimit the revitalisation area. The high level of this local priority is linked to the high number of indicators used. The diagnosis in LRP Bydgoszcz is in-depth and complete, which is also confirmed by the analysis of the descriptions of decision options.

The second stage of the comparative analysis relates to the final results obtained from the AHP. In the light of the evaluation criteria prepared for revitalisation programmes, the Local Revitalisation Programme of the City of Toruń for the years 2007–2015 was deemed the best. Based on the results of the AHP method it can be concluded that this programme responded best to the evaluation criteria identified at the outset. Despite the fact that the programme did not have a clearly formulated mission diagnosed at the decision option description stage, it received the highest value in the final matrix. This shows that this programme, in terms of multi-criteria decision-making, had the best impact on the revitalisation process. The second place in the hierarchy of programmes was taken by LRP Bydgoszcz. At this point, it should be noted that the best revitalisation programmes proved to be less structured, using different delimitation methods based on a larger number of indicators. RP Toruń and CRP Bydgoszcz were the least suited to the criteria. They received the lowest results in the final matrix procedure.

Summary

The idea of revitalisation is to bring a degraded area out of crisis based on a revitalisation programme. To use a legal metaphor, a revitalisation programme can be called a law and the revitalisation projects are its implementing acts. They directly improve urban spaces, the social and economic situation, and the environment.

The AHP method allowed us to combine the criteria of delimitation, financing, participation and monitoring of the revitalisation process. This broad approach to evaluation criteria helps show how the revitalisation process is conducted in a given city and in a given financial perspective. The AHP method enabled us to rank the revitalisation programmes based on predefined evaluation criteria. These criteria were evaluated by a group of revitalisation experts. The AHP analysis shows that the Local Revitalisation Programme of the City of Toruń for the years 2007–2015 responds best to the problems posed by the evaluation criteria. It can be concluded that a revitalisation programme formulated in this way best meets the needs of the process. The availability of the AHP method enables us to carry out a multidimensional evaluation of the revitalisation process based on different programmes. It allowed us to combine different elements of the evaluation of the revitalisation process and transform them into one synthetic result, ranking each programme in a hierarchy.

The revitalisation process can be evaluated using different quantitative research methods, as presented in this paper. However, it should be remembered that in order to optimise the results of quantitative research, it would be necessary to conduct qualitative research among the inhabitants, tourists and users of the post-revitalisation space, which would include an analysis of the previous and current revitalisation perspectives. Carrying out quantitative and qualitative research in synergy would allow a comprehensive evaluation of the revitalisation process.

Acknowledgments

The author would like to thank the anonymous reviewers for their insightful and constructive comments.

Author's contribution

Krzysztof Rogatka (40%): conceptualisation, investigation, visualisation, writing (draft and review). Tomasz Starczewski (40%): conceptualisation, methodology, visualisation, figure design and elaboration, writing (draft and review). Mateusz Kowalski (20%): visualisation, figure design and elaboration, writing (draft).

References

Acioly C., 2001. Reviewing urban revitalisation strategies in Rio de Janeiro: From urban project to urban management approaches. *Geoforum* 32(4): 509–520. DOI 10.1016/S0016-7185(01)00013-6.

Adair A., Berry J., McGreal S., Deddis B., Hirst S., 1999. Evaluation of investor behaviour in urban regeneration. *Urban Studies* 36(12): 2031–2045. DOI 10.1080/0042098992520.

Babbie E., 2003. *Badania społeczne w praktyce* (Social research in practice). Wydawnictwo Naukowe PWN, Warsaw.

Bednarowska Z., 2015. Desk research – wykorzystanie potencjału danych zastanych w prowadzeniu badań marketingowych i społecznych (Desk research: Exploiting the potential of secondary data in market and social research). *Marketing i rynek* 2015(7): 18–26.

Bury K., 2010. Zastosowanie wielokryterialnej metody QAT w ocenie programów i projektów rewitalizacji (The application of multi-criteria QAT method in the assessment of programs and projects of regeneration). In: Skalski K. (ed.), *O budowie metod rewitalizacji w Polsce – aspekty wybrane* (About building revitalization methods in Poland – selected aspects). Instytut Spraw Publicznych Uniwersytetu Jagiellońskiego, Kraków: 65–89.

Cęckiewicz W., 1989. *Rola i funkcja zespołów zabytkowych w rozwoju przestrzennym miast, aglomeracji i regionów. Raport z badań w ramach problemu międzyresortowego "Rewaloryzacja zespołów zabytkowych na tle rozwoju miast"* (The role and function of historic complexes in the spatial development of cities, agglomerations and regions. Research report as part of the inter-ministerial problem "Revalorization of historic complexes at the background of urban development"). Wydawnictwo Politechniki Krakówskiej, Kraków.

Çil İ., Arman H., 2001. An application of the analytic hierarchy management determining the relocation of Adapazari. *Sakarya Üniversitesi Fen Bilimleri Enstitüsü Dergisi* 5(1): 12–20.

Clerci A., Mironowicz I., 2009. Are landmarks essentials to the city – its development? REAL CORP, In: 14th International Conference on Urban Planning, Regional Development and Information Society, 22–25 April 2009, Spain.

Czyżewska A., 2003. Finansowanie programów rewitalizacji z Funduszy Strukturalnych (Financing of revitalisation programmes from the Structural Funds). *Świat Nieruchomości* 39, Krakówski Instytut Nieruchomości.

Czyżewska A., 2008. Modele rewitalizacji i ich zastosowanie (The models of revitalisation and their application). *Urbanista* 8: 29–30.

Domański B., 2009. Rewitalizacja terenów poprzemysłowych–specyfika wyzwań i instrumentów (Revitalisation of post-industrial areas: The specificity of challenges and instruments). *Przestrzenne aspekty rewitalizacji—śródmieścia, blokowiska, tereny poprzemysłowe, pokolejowe i powojskowe* 4: 125–138.

Dziurbejko T., 2006. *Planowanie rozwoju gminy jako instrument pozyskiwania funduszy pomocowych Unii Europejskiej* (Planning the development of a commune as an instrument for obtaining aid funds from the European Union). Difin, Warsaw.

Eisenhardt K.M., 1989. Building theories from case study research. *The Academy of Management Review* 14: 533–545.

Gao L., Hailu A., 2013. Identifying preferred management options: An integrated agent-based recreational fishing simulation model with an AHP-TOPSIS evaluation method. *Ecological Modelling* 249: 75–83.

Goodwin P., Wright G., 2011. *Analiza decyzji* (Decision analysis). Wolters Kluwer Polska, Warsaw.

Guidelines for revitalization in operational programmes for 2014–2020, Ministry of Funds and Regional Policy (Poland).

Heaton J., 2008. Secondary analysis of qualitative data: An overview. *Historical Social Research/Historische Sozialforschung* 33(3): 33–45.

Herbst I., 2009. *Warunki finansowania procesów rewitalizacji w gospodarce rynkowej* (Conditions for financing revitalisation processes in a market economy). (Report in project: PBZ-MniSW-4/3/2006). Szkoła Główna Handlowa, Warsaw.

Hermawan B., Sholihah A.B., Pramanasari P.A., 2019. Evaluation of the implementation of the revitalization program in preservation of van den Bosch fortress in Ngawi. *International Journal of Architecture and Urbanism* 3(1): 9–18. DOI 10.32734/ijau.v3i1.780.

Hofferth L., 2005. Secondary data analysis in family research. *Journal of Marriage and Family* 67(4): 891–907.

Jakubczyk K., Kitowski P., 2015. Społecznie odpowiedzialny projekt – opracowanie definicji na podstawie przeglądu literatury z zakresu społecznej odpowiedzialności i zarządzania projektami (Socially responsible project: Developing a definition based on a literature review in the field of corporate social responsibility and project management). *E-Mentor* 5: 50–64.

Jarczewski W., 2009. *Skala degradacji miast w Polsce* (The scale of urban degradation in Poland). Instytut Rozwoju Miast, Kraków.

Jarczewski W., Jeżak J., 2010. *System monitorowania rewitalizacji* (Revitalisation monitoring system). Instytut Rozwoju Miast, Kraków.

Kiecolt K.J., Brinberg D., Auspurg K., Nathan L.E., 1985. *Secondary analysis of survey data*. Sage, Newbury Park, London, New Delhi.

Kopeć M., 2011. *Finansowanie projektów rewitalizacji* (Financing of revitalisation projects). C.H. Beck, Warsaw.

Kostarczyk A., 2015. Miejska przestrzeń publiczna jako obszar zdegradowany (Urban public space as a degraded area). *Metropolitan Przegląd Naukowy* 1(3): 52.

Lorens P., 2000. Problemy rewitalizacji układów urbanistycznych osiedli socjalnych Gdańska okresu dwudziestolecia międzywojennego (Problems of revitalisation of urban layouts of social housing estates in Gdańsk in the interwar period). In: Cielątkowska R. (ed.), *Budownictwo społeczne I poł. XX w. w Europie. Problemy ochrony i rewitalizacji* (Social housing of the first half of the 20th century in Europe. Problems of protection and revitalisation). Wydział Architektury Politechniki Gdańskiej, Gdańsk.

Lorens P., 2016. Kształtowanie programów rewitalizacji miast w kontekście współczesnych przemian społeczno-ekonomicznych, doktrynalnych i prawnych (Shaping urban regeneration programmes in the context of contemporary socio-economic, doctrinal and legal changes). *Biuletyn KPZK* 264: 10–25.

Lubecka A., 2010. *Rewitalizacja/gentryfikacja jako element zmieniający semantykę miasta* (Revitalisation/gentrification as an element changing the semantics of the city). In: Skalski (ed.), *O budowie metod rewitalizacji w Polsce* (On the development of revitalisation methods in Poland). Monografie i Studia Instytutu Spraw Publicznych Uniwersytetu Jagiellońskiego, Kraków: 157–172.

Lubińska T., Franek S., Będziszek M., 2007. *Potencjał dochodowy samorządu w Polsce* (The income potential of local government in Poland). Difin, Warsaw.

Lynch K., 1960. *The image of the city*. The MIT Press, Cambridge Massachusetts.

Makowska M., 2012. *Analiza danych zastanych. Przewodnik dla studentów* (Analysis of desk research. Guide for students). Scholar, Warsaw.

Manganelli B., Tataranna S., Pontrandolfi P., 2020. A model to support the decision-making in urban regeneration. *Land Use Policy* 99: 104865. DOI 10.1016/j.landusepol.2020.104865.

Markowski T., 1999. *Zarządzanie rozwojem miast* (City development management). Wydawnictwo Naukowe PWN, Warsaw.

Milczyńska-Hajda D., 2009. *Rewitalizacja w Polsce. Aktualny stan i perspektywy* (Revitalisation in Poland. Current state and prospects). Konferencja "Miasto 2009 – zarządzanie miastem", Katowice.

Mironowicz I., Ossowicz T., 2005. Metodologia badania degradacji obszarów o funkcjach metropolitalnych (Methodology of studying the degradation of areas with metropolitan functions). *Biuletyn KPZK PAN* 223: 36–56.

Muzioł-Węcławowicz A., 2009. *Rewitalizacja dzielnic śródmiejskich. Przestrzenne aspekty rewitalizacji–śródmieścia, blokowiska, tereny poprzemysłowe, pokolejowe i powojskowe* (Revitalisation of downtown districts. Spatial aspects of revitalisation: Downtowns, blocks of flats, post-industrial, post-railway and post-military areas). Instytut Rozwoju Miast, Kraków.

Nawieśniak-Caesar M., Wilkosz-Mamcarczyk M., Hernik J., Gorzelany J., Gorzelany-Dziadkowiec M., 2019. An integrated approach to river valley revitalisation. *Journal of Environmental Engineering and Landscape Management* 27(1): 22–32.

Ogrodnik K., 2014. Możliwość implementacji metody AHP do procedury wyboru optymalnego wariantu lokalizacyjnego zespołu elektrowni wiatrowych (Chance for implementation of the AHP method in to the procedure of selection of the optimal localisation of the wind power plants). *Ekonomia i Środowisko* 1: 64–79.

Opoku E.E.O., Boachie M.K., 2020. The environmental impact of industrialization and foreign direct investment. *Energy Policy* 137: 111178. DOI 10.1016/j.enpol.2019.111178.

Parysek J.J., 2015. Miasto w ujęciu systemowym (The city in a systemic perspective). *Ruch prawniczy, ekonomiczny i socjologiczny* 77(1): 27–53.

Peng J., 2012. Selection of logistics outsourcing service suppliers based on AHP. *Energy Procedia* 17: 595–601.

Pietrzak M., Baran J., 2007. *Podstawy zarządzania. Studia przypadków i inne ćwiczenia aktywizujące* (Management basics. Case studies and other activating exercises). Warsaw University of Life Sciences, Warsaw.

Poczobut J., 2009. *Specyfika odnowy małych i średnich miast w Polsce* (The specificity of the renovation of small and medium-sized cities in Poland). Stowarzyszenie Forum Rewitalizacji, Kraków.

Porter L., Shaw K. (eds), 2013. *Whose urban renaissance?: An international comparison of urban regeneration strategies.* Routledge, London.

Principles of programming revitalisation projects in order to apply for funds under the Regional Operational Programme of the Kujawsko-Pomorskie Voivodeship for the years 2014–2020 constituting Appendix No. 10 to the Detailed Description of Priority Axes of the Regional Operational Programme of the Kujawsko-Pomorskie Voivodeship for the years 2014–2020.

Prusak A., Stefanów P., 2014. *AHP – Analityczny proces hierarchiczny. Budowa i analiza modeli decyzyjnych krok po kroku* (AHP – Analytical hierarchical process. Building and analysis of decision models step by step). C.H. Beck, Warsaw.

Resolution No. 624/09 of the Toruń City Council of August 29, 2009.

Resolution No. XLIX/728/09 of the Bydgoszcz City Council of June 24, 2009.

Resolution No. 922/18 of the Toruń City Council of September 6, 2018.

Resolution No. IV/12/18 of the Bydgoszcz City Council of November 28, 2018.

Roberts P., Sykes K., 2006. *Urban regeneration*. Sage Publications, London.

Roberts P., Sykes H., Granger R. (eds), 2016. *Urban regeneration*. Sage, London.

Rogatka K., 2019. *Rewitalizacja i gentryfikacja w wymiarze społecznym* (Revitalisation and gentrification in the social dimension). Wydawnictwo Naukowe, Nicolaus Copernicus University, Toruń.

Saaty T.L., 2004. Decision making – The analytic hierarchy and network processes (AHP/ANP). *Journal of Systems Science and Systems Engineering* 13(1): 1–35.

Saaty T.L., 2008. Relative measurement and its generalization in decision making. Why pairwise comparisons are central in mathematics for the measurement of intangible factors the analytic hierarchy/network process. *RACSAM-Revista de La Real Academia de Ciencias Exactes, Fisicas Y Naturales. Serie A. Matematicas* 102(2): 251–318.

Sdino L., Rosasco P., Lombardini G., 2020. The evaluation of urban regeneration processes. In: Della Torre S., Cattaneo S., Lenzi C., Zanelli A. (eds), *Regeneration of the built environment from a circular economy perspective*. Springer, Cham: 47–57.

Skalski K., 2006. *Projekty i programy rewitalizacji w latach 2000–2006*. Studium przypadków (Revitalisation projects and programmes in 2000–2006. Case study). Stowarzyszenie "Forum Rewitalizacji", Kraków.

Sobiech K., 2007. *Partnerstwo publiczno-prywatne w infrastrukturze drogowej w Polsce* (Public-private partnership in road infrastructure in Poland). Wydawnictwo Politechniki Poznańskiej, Poznań.

Solangi Y.A., Longsheng C., Shah S.A.A., 2021. Assessing and overcoming the renewable energy barriers for sustainable development in Pakistan: An integrated AHP and fuzzy TOPSIS approach. *Renewable Energy* 173: 209–222.

Sosnova N., Wilkosz-Mamcarczyk M., 2017. Developing "green" public spaces as a path to urban revitalisation of residential-industrial zones. *Geomatics, Landmanagement and Landscape* 4: 95–104.

Starczewski T., Rogatka K., Kowalski M., 2022. Evaluation of revitalisation projects in Poland using the Maslin Multi-Dimensional Matrix. Heading towards green & social revitalisation. *Bulletin of Geography. Socio-Economic Series* (55): 123–139. DOI 10.12775/bgss-2022-0009.

Szlachetko J., Szlachetko K., 2019. *Udział interesariuszy w kształtowaniu i prowadzeniu polityki rewitalizacyjnej* (Participation of stakeholders in shaping and conducting the revitalisation policy). Instytut Metropolitalny, Gdańsk.

Wilkosz-Mamcarczyk M., 2018. Greenary in the revitalization processes of post-industrial areas in the Ruhry and the Upper Silesian Industrial Districts. *Przestrzeń i Forma* 33: 253–266.

Yin R.K., 2003. *Case study research. Design and methods*. Sage Publications, London.

Appendix

Criterion 1. Number of indicators used to delimit the revitalisation area

Table A1. Pairwise comparison – Criterion 1.

Number of indicators used to delimit revitalisation area	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
LRP Toruń 2007–2015	1.00	2.00	0.14	2.00
CRP Toruń 2016–2023	0.50	1.00	0.17	1.00
LRP Bydgoszcz 2007–2015	7.00	6.00	1.00	6.00
CRP Bydgoszcz 2016–2023	0.50	1.00	0.17	1.00
Total	9.00	10.00	1.48	10.00

Source: own elaboration.

Table A2. Normalised matrix values and criterion weight 1.

Number of indicators used to delimit revitalisation area	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023	Weight
LRP Toruń 2007–2015	0.11	0.20	0.10	0.20	0.15
CRP Toruń 2016–2023	0.06	0.10	0.11	0.10	0.09
LRP Bydgoszcz 2007–2015	0.78	0.60	0.68	0.60	0.66
CRP Bydgoszcz 2016–2023	0.06	0.10	0.11	0.10	0.09

Source: own elaboration.

Matrix calculation for Criterion 1:

$$\begin{bmatrix} 1 & 2 & 1/7 & 2 \\ 1/2 & 1 & 1/6 & 1 \\ 7 & 6 & 1 & 6 \\ 1/2 & 1 & 1/6 & 1 \end{bmatrix} \times \begin{bmatrix} 0.15 \\ 0.09 \\ 0.66 \\ 0.09 \end{bmatrix} = \begin{bmatrix} 0.62 \\ 0.37 \\ 2.83 \\ 0.37 \end{bmatrix}$$

Table A3. Eigenvector of the matrix – Criterion 1.

Number of indicators used to delimit revitalisation area	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
Eigenvector of matrix	4.05	4.03	4.27	4.03

Source: own elaboration.

Largest eigenvalue of the matrix – Criterion 1

$$\lambda_{max} = \frac{4.05 + 4.03 + 4.27 + 4.03}{4} = 4.09$$

The values of the concordance index and the matrix concordance coefficient are given as:

$$CI = \frac{4.09 - 4}{3} = 0.03$$

$$CR = \frac{0.03}{0.89} = 0.034$$

CR ≤ 0.10, and therefore the criterion 1 matrix is consistent.

Criterion 2. Project value per one inhabitant of the revitalisation area

Table A4. Pairwise comparison – Criterion 2.

Project value per one inhabitant of revitalisation area	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
LRP Toruń 2007–2015	1.00	4.00	5.00	0.17
CRP Toruń 2016–2023	0.25	1.00	2.00	0.14
LRP Bydgoszcz 2007–2015	0.20	0.50	1.00	0.13
CRP Bydgoszcz 2016–2023	6.00	7.00	8.00	1.00
Total	7.45	12.50	16.00	1.43

Source: own elaboration.

Table A5. Normalised matrix values and criterion weight 2.

Project value per one inhabitant of revitalisation area	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023	Weight
LRP Toruń 2007–2015	0.13	0.32	0.31	0.12	0.22
CRP Toruń 2016–2023	0.03	0.08	0.13	0.10	0.08
LRP Bydgoszcz 2007–2015	0.03	0.04	0.06	0.09	0.05
CRP Bydgoszcz 2016–2023	0.81	0.56	0.50	0.70	0.64

Source: own elaboration.

Matrix calculation for Criterion 2:

$$\begin{bmatrix} 1 & 4 & 5 & 6 \\ 1/4 & 1 & 2 & 1/7 \\ 1/5 & 1/2 & 1 & 1/8 \\ 6 & 7 & 8 & 1 \end{bmatrix} \times \begin{bmatrix} 0.22 \\ 0.08 \\ 0.05 \\ 0.64 \end{bmatrix} = \begin{bmatrix} 0.94 \\ 0.34 \\ 0.22 \\ 2.99 \end{bmatrix}$$

Table A6. Eigenvector of the matrix – Criterion 2.

Project value per one inhabitant of revitalisation area	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
Eigenvector of matrix	4.24	4.02	4.08	4.67

Source: own elaboration.

Largest eigenvalue of the matrix – Criterion 2

$$\lambda_{max} = \frac{4.24 + 4.02 + 4.08 + 4.67}{4} = 4.25$$

The values of the concordance index and the matrix concordance coefficient are as under:

$$CI = \frac{4.25 - 4}{3} = 0.083$$

$$CR = \frac{0.083}{0.89} = 0.034$$

CR ≤ 0.10, and therefore the criterion 2 matrix is consistent.

Criterion 3. Share of projects submitted by non-municipal entities in the total number of submitted revitalisation projects

Table A7. Pairwise comparison – Criterion 3.

Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
LRP Toruń 2007–2015	1.00	4.00	3.00	0.50
CRP Toruń 2016–2023	0.25	1.00	0.33	0.20
LRP Bydgoszcz 2007–2015	0.33	3.00	1.00	0.17
CRP Bydgoszcz 2016–2023	2.00	5.00	6.00	1.00
Total	3.58	13.00	10.33	1.87

Source: own elaboration.

Table A8. Normalised matrix values and criterion weight 3.

Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023	Weight
LRP Toruń 2007–2015	0.28	0.31	0.29	0.27	0.29
CRP Toruń 2016–2023	0.07	0.08	0.03	0.11	0.07
LRP Bydgoszcz 2007–2015	0.09	0.23	0.10	0.09	0.13
CRP Bydgoszcz 2016–2023	0.56	0.38	0.58	0.54	0.51

Source: own elaboration.

Matrix calculation for Criterion 3:

$$\begin{bmatrix} 1 & 4 & 3 & 1/2 \\ 1/4 & 1 & 1/3 & 1/5 \\ 1/3 & 3 & 1 & 1/6 \\ 2 & 5 & 6 & 1 \end{bmatrix} \times \begin{bmatrix} 0.29 \\ 0.07 \\ 0.13 \\ 0.51 \end{bmatrix} = \begin{bmatrix} 1.21 \\ 0.29 \\ 0.52 \\ 2.21 \end{bmatrix}$$

Table A9. Eigenvector of the matrix – Criterion 3.

Share of projects submitted by non-municipal entities in total number of submitted revitalisation projects	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
Eigenvector of matrix	4.23	4.03	4.11	4.29

Source: own elaboration.

Largest eigenvalue of the matrix – Criterion 3

$$\lambda_{max} = \frac{4.23 + 4.03 + 4.11 + 4.29}{4} = 4.17$$

The values of the concordance index and the matrix concordance coefficient are as under:

$$CI = \frac{4.17 - 4}{3} = 0.056$$

$$CR = \frac{0.056}{0.89} = 0.064$$

CR ≤ 0.10, and therefore the criterion 3 matrix is consistent.

Criterion 4. Number of monitored areas in relation to the total number of areas

Table A10. Pairwise comparison – Criterion 4.

Number of monitored areas in relation to total number of areas	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
LRP Toruń 2007–2015	1.00	1.00	1.00	1.00
CRP Toruń 2016–2023	1.00	1.00	1.00	1.00
LRP Bydgoszcz 2007–2015	1.00	1.00	1.00	1.00
CRP Bydgoszcz 2016–2023	1.00	1.00	1.00	1.00
Total	4.00	4.00	4.00	4.00

Source: own elaboration.

Table A11. Normalised matrix values and criterion weight 4.

Number of monitored areas in relation to total number of areas	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023	Weight
LRP Toruń 2007–2015	0.25	0.25	0.25	0.25	0.25
CRP Toruń 2016–2023	0.25	0.25	0.25	0.25	0.25
LRP Bydgoszcz 2007–2015	0.25	0.25	0.25	0.25	0.25
CRP Bydgoszcz 2016–2023	0.25	0.25	0.25	0.25	0.25

Source: own elaboration.

Matrix calculation for Criterion 4:

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix} \times \begin{bmatrix} 0.25 \\ 0.25 \\ 0.25 \\ 0.25 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$$

Table A12. Eigenvector of the matrix – Criterion 4.

Number of monitored areas in relation to total number of areas	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
Eigenvector of matrix	4	4	4	4

Source: own elaboration.

Largest eigenvalue of the matrix – Criterion 4

$$\lambda_{max} = \frac{4 + 4 + 4 + 4}{4} = 4$$

λ_{max} is equal to the number of compared elements, and therefore the matrix of criterion 4 is fully consistent.

Criterion 5. Number of indicators used to monitor the revitalisation process

Table A13. Pairwise comparison – Criterion 5.

Number of indicators used to monitor revitalisation process	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
LRP Toruń 2007–2015	1.00	5.00	4.00	4.00
CRP Toruń 2016–2023	0.20	1.00	0.50	0.50
LRP Bydgoszcz 2007–2015	0.25	2.00	1.00	1.00
CRP Bydgoszcz 2016–2023	0.25	2.00	1.00	1.00
Total	1.70	10.00	6.50	6.50

Source: own elaboration.

Table A14. Normalised matrix values and criterion weight 5.

Number of indicators used to monitor revitalisation process	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023	Weight
LRP Toruń 2007–2015	0.59	0.50	0.62	0.62	0.58
CRP Toruń 2016–2023	0.12	0.10	0.08	0.08	0.09
LRP Bydgoszcz 2007–2015	0.15	0.20	0.15	0.15	0.16
CRP Bydgoszcz 2016–2023	0.15	0.20	0.15	0.15	0.16

Source: own elaboration.

Matrix calculation for Criterion 5:

$$\begin{bmatrix} 1 & 5 & 4 & 4 \\ 1/5 & 1 & 1/2 & 1/2 \\ 1/4 & 2 & 1 & 1 \\ 1/4 & 2 & 1 & 1 \end{bmatrix} \times \begin{bmatrix} 0.58 \\ 0.09 \\ 0.16 \\ 0.16 \end{bmatrix} = \begin{bmatrix} 2.35 \\ 0.37 \\ 0.66 \\ 0.66 \end{bmatrix}$$

Table A15. Eigenvector of the matrix – Criterion 5.

Number of indicators used to monitor revitalisation process	LRP Toruń 2007–2015	CRP Toruń 2016–2023	LRP Bydgoszcz 2007–2015	CRP Bydgoszcz 2016–2023
Eigenvector of matrix	4.06	4.01	4.02	4.02

Source: own elaboration.

Largest eigenvalue of the matrix – Criterion 5

$$\lambda_{max} = \frac{4.06 + 4.01 + 4.02 + 4.02}{4} = 4.03$$

The values of the concordance index and the matrix concordance coefficient are as under:

$$CI = \frac{4.03 - 4}{3} = 0.01$$

$$CR = \frac{0.01}{0.89} = 0.011$$

CR ≤ 0.10, and therefore the criterion 5 matrix is consistent.