

COMPARATIVE INDICATOR ANALYSIS BASED ON AGGREGATED DATA IN THE CONTEXT OF NEEDS AND INTERPRETATIVE POSSIBILITIES IN PROCEDURAL TERMS

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Purpose: The aim of the work was to demonstrate the interpretation possibilities caused by the presentation of prepared information being the result of analytical work, and influencing the final assessment resulting in the perception of the examined phenomena or the state of the examined object, but also indicating directions and finally ways of proceeding, i.e. potential or recommended actions.

Design/methodology/approach: A procedural approach to the issue of comparative indicator analysis allowing to demonstrate the needs and possibilities of interpretation requires aggregated data sets, necessary for the proper conduct of inference activities, which translates into the perception of the examined object or issue.

Findings: The analysis of the existence of interdependencies or their absence is determined by both the procedure and reliable data, hence the procedurally structured considerations, carried out in subsequent stages of analytical comparative work, make it possible to demonstrate the existing similarities, connections or problems.

Social implications: Indicative comparative analysis is a tool for collecting information about an object or phenomenon, taking into account a broader context, i.e. society, economy or the state of infrastructure. This gives the opportunity to compare the tested object on the basis of the background, enabling conclusions and recommendations.

Originality/value: Limiting the interpretative differences of the studied phenomena allows, on the basis of the background, i.e. references to the environment and identified trends, to predict development directions, and by making future states more probable, to propose final assessments that translate into recommendations or procedures.

Keywords: indicator analysis, multi-criteria assessment, procedure, aggregated data, indicators.

Category of the paper: Conceptual paper and Case study.

1. Introduction

Indicator analysis makes it possible to compare and interpret, and consequently predict future states (Kafel, 2013). It also makes it possible to derive recommendations - based on the adopted assumptions - relating to the analyzed issues or objects, taking into account the social, economic or infrastructural situation (Bernat, 2022). This approach makes it possible to discover and, ultimately, describe the existing dependencies, but also similarities or differences, and even disproportions that occur in real conditions, including those that are difficult to grasp (Eisenhardt, Sull, 2001).

The activities carried out at the stage of analytical work are used to collect the necessary information so that, after processing, it is possible to present the results (Dalecka, 2016) in terms that are relevant from the point of view of the adopted research assumptions. Such algorithmic action in the form of a procedure is laborious and time-consuming (The Global Competitiveness Report 2016/2017, 2016). Analytical work is multi-stage, and the search for correlations may lead to the recognition of interdependencies, but it does not ensure that (Jak przeprowadzić analizę danych..., 2020). Just noticing and describing difficult to detect or highlighting existing differences, thanks to the conducted analytical work, creates the basis for further work, directing the activities - including inference - to recommendations or ways of proceeding.

Comparative analysis can be seen as a useful tool for gathering information about an object or phenomenon, taking into account the situation of society, the economy or the state of infrastructure (Bernat, 2017). It will be possible only on the basis of aggregated data, which will allow to demonstrate the occurrence of different states in the considered areas of the analyzed issues (Human Development Reports, 2020). This gives the possibility of structuring and hierarchization, but also synthesis indicating potential opportunities in the future (The Global Competitiveness Report 2016/2017, 2016). Hence the assumption that the comparative analysis carried out in this way will make it possible to demonstrate the presence or absence of similarities, connections or problems.

A comparative analysis of the researched issue, object or phenomenon, e.g. in relation to a given community, region or entity, should not be conducted without ignoring the background of problems or potential interdependencies (Stępień, 2016). Therefore, by definition, it should be required to describe the specific situation resulting from the conducted analysis, taking into account the general conditions constituting the point of reference. The purpose of such proceedings would be to obtain information correcting the final conclusions. Such an approach should be considered appropriate, as it allows for the discovery or highlighting of the features of the examined objects against the analytical background (Uchwała KRBR 2015), which enables the search to be directed and in-depth analysis aimed at bringing the recommendations and resulting actions closer to real, and not only identified needs. Hence, the aim of the work was to show possible differences in interpretation caused by the presentation of prepared

information being the result of analytical work, and affecting the final assessment resulting in the perception of the studied phenomena or the state of the tested object, but also indicating directions or, finally, ways of proceeding, i.e. potential or recommended actions. An example of this approach is choice of the most suitable indicator framework is comparison indicator standards for Smart sustainable cities (Huovila, Bosch, Airaksinen, 2019).

The comparative analysis is used to use a variety of assessments, such as determining the optimal solution (Fadda et al., 2021) or comparisons of methods of assessing the results of enterprises (Narkunienė, Ulbinaitė, 2018), but the approach related to limiting interpretative differences is not represented in the literature on the subject. This is particularly important in the context of available aggregated data. A special issue was devoted to the consequences of differences in the interpretation of the studied phenomena, which included articles aimed at stimulating the debate regarding the criteria for assessing aggregated data for the purposes of comparative analyses (Neumann, Graeff, 2015).

Analytical works should, if possible and certainly justified, cover a designated time space, e.g. months or years, indicating regularities (Lachowski, 2019), i.e. trends or tendencies describing the changes taking place or their absence, i.e. refer to the interpretative location in space-time. This, in turn, requires the search for indicators reflecting the suggested perspective of looking at the analyzed issue or object. Wanting to get a fuller picture of "the level of human development in a given country requires the collection of a lot of information from various, and above all, reliable and objective, and therefore verifiable sources and the analysis of indicators reflecting the current state of the quality of life of residents, and not only the country or economy" (Bernat, 2019). This constitutes a challenge for researchers at the stage of preparing analytical works.

2. Multi-criteria assessment

The challenges of the preparatory stage result not only from the adopted goals or criteria, but also from the way of describing the condition of the examined objects or issues, e.g. phenomena affecting society and related to poverty, inequality, climate, environmental degradation, prosperity or, to a lesser extent, from the way of describing the condition economy or finance, as well as geopolitical location or infrastructural problems (Ciais et al., 2021). These difficulties are a challenge, and at the same time an impulse to describe not only current or temporary states, but also to conduct analytical work in the context of the probability of occurrence of specific events in the future on the basis of available historical data (Matthew et al.).

Multi-criteria analysis allows for the compilation of various indicators describing the state of the object (issue) or the course of the phenomenon and comparing them for selected references. As part of the case study, the object (country) was analyzed on the basis of the background by referring it to the reference environment. A number of criteria were used in the inference, which enable the assessment of the functioning of the tested object in various areas. And as shown in Fig. 1, the analysis may include a number of criteria regarding the tested object and the reference background. The scale of ratings used allows, in turn, to quantify the existing similarities or differences.

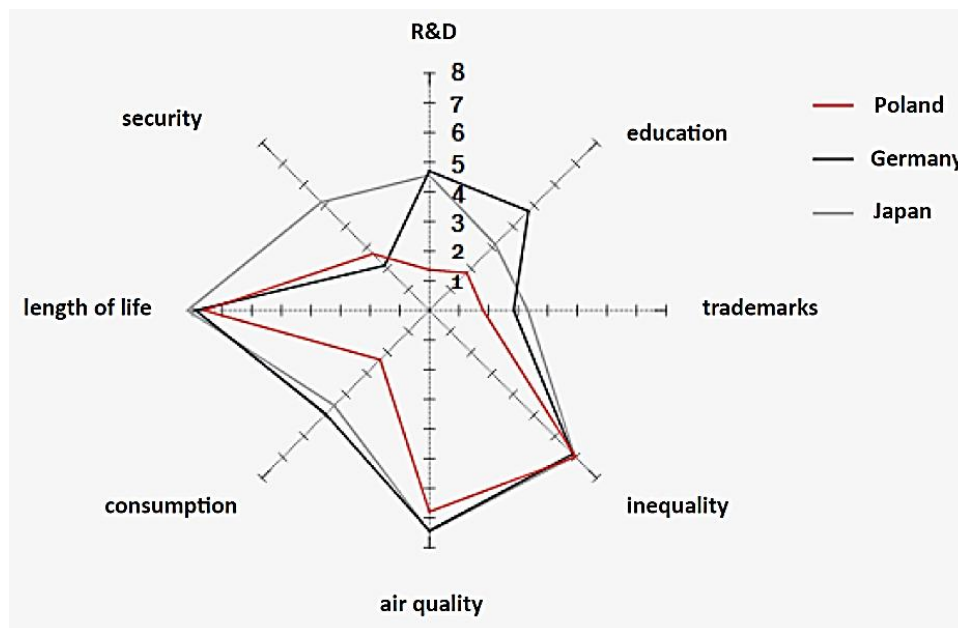


Figure 1. Multi-criteria analysis of the object based on the background.

Source: http://pie.net.pl/wp-content/uploads/2019/02/PIE-Indeks_Odpowiedzialnego_Rozwoju.pdf, 1.04.2020.

Fig. 1 characterizes the situation of Poland against the background of developed economies, namely Germany and Japan. Such imaging shows the distance between the tested object and the leaders or reference objects. Nevertheless, when analyzing the situation of a given facility (country), one should not only check how it compares to the leaders, but also make comparisons with similar facilities (in this case, countries of the region). Therefore, the situation of the examined object should also be compared to objects -constituting the background- of similar "parameters". In the cited example, Poland had to be compared with culturally, economically and geographically similar countries of the Visegrad Group. Such a comparison showed that the results in terms of the examined indicators constituting the assessment criteria do not differ significantly for the countries of Central and Eastern Europe (Bernat, 2019). In the case of the Visegrad Group, differences emerged in areas such as: security, R&D and trademarks. The criteria listed in Fig. 1 are components of the responsible development index (IOR) enabling multi-criteria assessment (Polish Economic Institute, 2019).

As shown in Fig. 1, in comparison to countries such as Germany or Japan, there are significant differences in five out of eight criteria adopted for the analysis. Therefore, the presentation of the object against the background of other references shows the main directions and scale of challenges in catching up the distance between the tested object and the research background, taking into account the considered criteria.

It should be noted that the countries analyzed in Fig. 1, similarly to the countries of the Visegrad Group, are classified - according to the HDI (Human Development Statistical (2019)) - as very developed countries, but there are significant differences between them. Fig. 1 shows that life expectancy (8) and the level of inequality (7) are the criteria in which Poland's assessments are comparable to the analytical background and are very high (max. 8). There is a small distance between Poland (6.75) and Japan and Germany (7.5) in the case of air quality, but in terms of safety, the differences between Poland (2.5) and Germany (2) and Japan (5) are significant. European countries clearly lose half the distance. This illustrates the need to examine many criteria in order to highlight the occurrence of similarities, but also differences.

Collecting not so much useful as comparable data can also be problematic. In the analyzed case, these will be areas such as expenditure on education or expenditure on research and development, where the differences shown will require interpretation. Therefore, it seems reasonable to ask whether these interpretations will not affect the usability understood as data comparability. The answer to such a problem should be sought in the multi-criteria analysis, which is necessary to determine the current state. This will make it possible to identify possible future states and, consequently, to plan actions aimed at improving the situation in the studied areas.

Comparative analysis carried out in stages makes it possible to highlight a number of dependencies, at the same time illustrating -necessary for the proper conduct of the synthesis process-the links and complexity of these links. This leads to the question of whether the reference of the situation of the tested object to the background, i.e. preparatory analytical activities from the point of view of the proposed procedure, will be sufficient to discover and describe the existing complexity correctly (Staruch, 2019). Since the connections are unclear and the processes take place over time, the connections assessed after the fact will be an indicator of changes, translating into conclusions. Therefore, the conclusions resulting from the conducted analyzes may be subject to a certain degree of uncertainty, which in the extreme case may exclude them as a reliable research material for further work. This is especially important in the case of comparative analysis. Therefore, the analysis should be carried out in stages, so that - on the basis of the analytical background - it is possible to show dependencies in relation to the examined object or the analyzed issue. Hence the proposal of a procedure in accordance with the order of the procedure, namely: a) background analysis, b) analysis of the main issue, c) searching for and, consequently, demonstrating analytical connections or their absence. Comparative analysis therefore appears as a tool for balancing the uncertainty

accompanying research work, but only on the condition of properly conducted analytical work taking into account its phased nature.

The procedure described above is a consequence of the research assumption, indicating the need to conduct a targeted analysis to enable an indicator assessment that meets the needs of interpretation. Interpretation possibilities, in turn, result from the adopted assessment criteria. Hence, systematic considerations in the form of analytical comparative works aimed at demonstrating the existing similarities, connections or problems and their correlation seem to be the most advantageous analytical approach, i.e. a procedure providing a range of useful, reliable and, above all, comparable information.

3. Comparative analysis

A comparative analysis describing the social, economic or infrastructural situation in a broader context requires criteria and assessments that allow - not so much for measurement, but as a consequence - to compare the examined object (issue) with the environment (Bernat, 2019). Both reliable data and the correct procedure are necessary to achieve the research assumptions, but in order to implement such a process and obtain a positive correlation effect, it is necessary to carry out an analysis of the initial state in order to indicate the areas that should be included in the comparative analysis, but also to determine how to measure and assess the condition described by a given criterion (Rostkowski, 2019). The starting point for such considerations may be, for example: the social or economic situation analyzed in relation to the analytical background, not only in local but also global terms.

An example of the above-mentioned approach may be the Human Development Index (HDI), which reflects the quality of life, i.e. the situation of residents, describing very important, if not basic, areas of functioning of given communities, such as long and healthy life, knowledge and standard of living. In turn, an example of a useful aggregated data set is the statistical annex (Human Development Statistical, 2019) to the report on the standard of living, on the basis of which analyzes can be conducted in correlation with the HDI index. The possibilities of presenting the collected information are presented in Table 1. Such a juxtaposition shows the situation of the examined object (in the analyzed example, it concerns the country) against the background of the others, which will be the starting point for further analytical work.

Table 1.
Human Development Index HDI and its components

HDI 2017	Country/development level of the group/region	HDI	The life expectancy at birth	Expected years of schooling	Mean years of schooling	GNI per capita	HDI '16
Pos.	Name	value	number of years	number of years	number of years	2011 PPP \$	Pos.
5	Niemcy	0,936	81,2	17	14,1	46136	4
19	Japonia	0,909	83,9	15,2	12,8	38 986	19
-	b. wysoki	0,894	79,5	16,4	12,2	40 041	-
27	Czechy	0,888	78,9	16,9	12,7	30 588	27
33	Polska	0,865	77,8	16,4	12,3	26 150	34
38	Słowacja	0,855	77,0	15,0	12,5	29 467	39
45	Węgry	0,838	76,1	15,1	11,9	25 395	45
-	Europa i Azja Środk.	0,771	73,4	14,1	10,3	15 331	-

Note. Gross national income (GNI) per capita estimated using purchasing power parity (PPP).

Source: http://hdr.undp.org/sites/default/files/2018_human_development_statistical_update.pdf, 30.03.2020.

The HDI index (Table 1) makes it possible to compare social development. Dimensions describing the living space of the inhabitants of a given community (country) - i.e., a) the health dimension resulting from the assessment relating to life expectancy, b) the educational dimension defined as the average years of education for adults aged 25 and more and the expected years of education for children of school age starting education and c) the dimension reflecting the standard of living, which is determined by gross national income per capita (GNI per capita) - are the information basis for guiding further work.

Poland, like the other analyzed countries, is in the group of countries with a very high development index (33rd place in 2017 - an advancement by one place in the ranking compared to 2016, which takes into account the time factor) (Human Development Reports..., 2019). However, Poland, the Czech Republic and Hungary are below the average (0.894) of the HDI for very highly developed countries, which illustrates the differences.

The use of gross national income (GNI) per capita to assess the situation of inhabitants in the HDI index reduces the spreads that occur when using GDP as a measure, which also results from the use of the purchasing power parity rate (PPP). These differences - in the considered period - are significant, because in Poland GDP per capita is USD 13,811.66, and GNI measured (PPP) is USD 26,150, so GNI (PPP) is almost twice (1.893) higher than GDP. For comparison, the Czech Republic's GNI/GDP is 30588/20368.14, i.e. GNI(PPP) is 1.5 times higher than GDP. On the other hand, the GNI/GDP of Germany 46136/44469.91 (1.037) or Japan's GNI/GDP 38986/38428.10 (1.014) illustrate the existence of a different type of differentiation. Countries with very high development, which include Poland and other analyzed countries, occupy positions from 1 to 58, but within this ranking there are significant disproportions between them, which was shown by the comparison and differences in GDP and GNI. The observed discrepancies may have analytical consequences. The quoted comparison of GDP with GNI reflects the occurrence of significant or even fundamental differences, which illustrates the problem of interpretation possibilities resulting from the adopted indicator.

The assessment of the situation of individual objects (e.g. countries) or issues is crucial, but also difficult to carry out in practice, because it requires the use of a set of comparable criteria that reflect the situation, i.e. those that describe the reality and determine their value for the examined objects, also in the framework -if it's possible- of the research assumptions time horizon, which determines the adopted goal of the work, both in terms of needs and interpretation possibilities, translating into ("correct" - it should be clarified in context) recognition of implementation possibilities, i.e. an objective assessment of the situation. This requires the use of indicators that allow for comparative analysis. The use of generally known and commonly used global indicators, such as: GDP, HDI or locally developed indicators, such as the responsible development index (IOR) or sustainable development index (IZR) will be an acceptable way to measure the level of the status of the phenomenon (issue) or object under study at the stage of preliminary analytical work. However, the analysis of the background will not always be a reliable description of the examined dependencies, e.g. quality of life, which has been demonstrated by comparing the GDP and GNI indicators. Therefore, the reference to the environment, i.e. the study of the background, systematizes the situation of individual objects (e.g. countries) directing further work including analyzes of issues relevant in the context of possible mutual interactions, i.e. potential links, dependencies or interactions.

4. Conclusions

Comparative analysis, the purpose of which is to describe the occurring phenomena or to demonstrate the current state of the tested object against the reference background, is both a substantive and procedural challenge, so that the demonstrated dependencies or identified discrepancies are a description of the actual state, and not a reflection of interpretation differences related to the information the content of the presented indicators or a specific perspective of the application process. The need to provide reliable and comparable data requires a balance to be struck between the cross-cutting and the detailed nature of the issues covered at the preparatory stage. This prompts the search for methods that enable conducting targeted analytical work, as well as the use of stages in these works, which end with the algorithmization of the procedure, both at the stage of collecting information, as well as its development or visualization.

Both verifiable data and the correct procedure are the elements necessary to achieve the research assumptions, i.e. the description of the actual situation, the purpose of which is to demonstrate the presence or absence of connections and interactions, and thus correlation or lack thereof. The analysis of the initial state, by indicating the areas of comparative analysis, but also by defining the measures necessary to assess the state of the described objects and phenomena, requires many criteria, because only then can the considerations be conducted

contextually, e.g. in relation to the social situation or in relation to broader analytical background, both locally and globally. Sets of measures of indicators that take into account different assessment perspectives require more expenditure at the stage of analytical work. At the same time, this enables a more cross-sectional search of data sets in order to capture and highlight the existing differences, which in turn gives the opportunity not so much to improve the interpretation match as to limit interpretation differences, which are also a consequence of the analytical procedure itself.

Comparative indicative analysis based on aggregated data makes it possible to describe the situation of a given object or issue, taking into account the needs, but also interpretation possibilities. However, in order for the obtained information to be reliable, analytical work is necessary, taking into account both the reference background and multi-criteria indicative characteristics. The analysis of the background with the similarities shown allows to search for differences and indicate convergences, which may become the basis for further analytical work at the stage of studying the proper phenomena. Ratio analysis based on aggregated data improves procedural efficiency, but also reduces interpretation discrepancies, which is particularly important in the context of searching for correlations or showing dependencies that give a picture of probable future states at the stage of studying the phenomena proper.

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