COMPARATIVE INDICATOR ANALYSIS BASED ON AGGREGATED DATA IN THE CONTEXT OF NEEDS AND INTERPRETATIVE POSSIBILITIES IN A TEMPORAL APPROACH

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Purpose: The aim of the work was to demonstrate the interpretation possibilities offered by the presentation of prepared information, which is the result of analytical work and influences the final assessment resulting in the perception of the studied phenomena or the state of the studied object, but also indicates potential or possible interpretational distortions, i.e. potentially erroneous recommendations.

Design/methodology/approach: A temporal approach to the issue of comparative indicator analysis that allows for the demonstration of interpretational distortions requires aggregated data sets that are necessary for the correct 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 conditioned by both the time period and reliable data, hence the structured considerations conducted in the subsequent stages of the analytical comparative work will allow for the demonstration of existing similarities, differences or problems.

Social implications: Indicator comparative analysis is a tool for collecting information about an object or phenomenon, taking into account the broader context, i.e. society, economy or state of infrastructure. This gives the possibility of comparing the studied object based on the background, enabling conclusions and recommendations.

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

Keywords: indicator analysis, multi-criteria evaluation, interpretational distortions, aggregated data, indicators.

Category of the paper: Conceptual paper and Case study.

1. Introduction

Comparative analyses can be both quantitative and qualitative (Potocki, Lasota, 2021). Quantitative methods include searching for patterns, creating forecasts and testing causal

relationships, as well as generalizing the obtained results (Rana, Gutierrez, Oldroyd, 2012). The studies concern broadly understood recommendations, such as inventory management in the context of demand and competition with market shares (Seyed, Zohreh, 2019).

Comparative indicator analysis enables interpretation and ultimately prediction of future states (Kafel, 2013). It also enables deriving recommendations related to the analyzed issues or objects, taking into account the situation in a broader context (Bernat, 2022). This approach enables the discovery and ultimately description of existing relationships, but also similarities or differences, and even interpretational distortions of actual conditions, including time changes that are difficult to capture (Eisenhardt, Sull, 2001). Hence, comparative analysis can be seen as a useful tool for collecting information about an object or phenomenon, taking into account the context of the social, economic or infrastructural situation (Bernat, 2017). This will only be possible on the basis of aggregated data, which will allow to demonstrate the occurrence of various states, including those resulting from the time of the process (Human Development Reports, 2020). This allows for the comparison of temporarily stable states, but also a synthesis indicating potential differences in conditions (The Global Competitiveness Report 2016/2017, 2016). Hence the assumption that comparative analysis conducted in this way will allow to demonstrate the presence or absence of similarities, connections or problems, and in particular to highlight interpretational distortions.

The activities performed at the analytical stage serve to collect the necessary information so that after processing it is possible to present the results (Dalecka, 2016) in categories that are important from the point of view of the adopted research assumptions. Such algorithmic procedural activities are laborious and time-consuming (The Global Competitiveness Report 2016/2017, 2016). Analytical work is multi-stage, and the search for correlations can lead to the recognition of interdependencies (How to conduct reliable documentation…, 2020). The mere noticing and describing difficult to detect or highlighting existing differences or distortions creates a basis for further work, directing them and, consequently, drawing conclusions on recommendations or methods of conduct.

Comparative analysis is used to compare various assessments, such as determining the optimal solution (Fadda et al., 2021) or comparing methods of assessing enterprise performance (Narkunienė, Ulbinaitė, 2018), but the approach related to limiting differences in interpretation is still not sufficiently represented in the literature. This is especially important in the context of available aggregated data. The consequences of differences in the interpretation of the studied phenomena were the subject of the study, in which the discussion aimed to dynamize the debate on the criteria for assessing aggregated data needed for comparative analyses (Neumann, Graeff, 2015).

The comparative analysis of the examined issue should take into account the background of problems or potential interdependencies (Stępień, 2016). Therefore, by definition, the description of the state or process resulting from the conducted analysis should be related to the general conditions constituting the reference point (Bernat, 2022). The aim of such

a procedure is to obtain information correcting the final conclusions. Such an approach is possible and necessary, as it allows to discover or highlight the features of the examined issues against the analytical background (Uchwała KRBR, 2015). This allows to direct the search and conduct an in-depth analysis aimed at bringing the recommendations and the resulting actions closer to the actual, and not only identified needs (Athiyarath, Krishnaswamy, 2020). Hence, the aim of the work was to show possible differences in interpretation caused by the presentation of prepared information resulting from analytical work and influencing the final assessment resulting in the perception of the examined phenomena or the states of the examined object. An example of such an approach is the work describing the selection of benchmarking standards for smart, sustainable cities (Huovila, Bosch, Airaksinen, 2019). This approach is intended to enable indicating directions and methods of action, which is reflected in potential or recommended actions.

2. Comparative multi-criteria analysis

Comparative multi-criteria analysis allows for the compilation of various indicators describing the state of the object being studied or the course of the phenomenon and comparing them for selected criteria (Bernat, 2023). For example, if a selected object was analyzed, then based on the background using a number of criteria, it is possible to assess the functioning of the object being studied in various areas. In the cited example, the assessment of the object allows for indicating similarities or differences, and this in the context of leaders or objects forming the same group. Hence the conclusion that the situation of the object being studied should be related not only to leaders (Bernat, 2019). Then, it is possible to indicate significant differences within the framework of the criteria adopted for analysis. This in turn illustrates the main directions and scale of challenges and the distance between the object being studied and the research background.

The challenges of the preparatory stage result not only from the adopted goals or criteria, but also from the way of describing the issues studied relating to society (poverty, inequality, well-being) or, to a lesser extent, the economy (economy, finances), as well as the geopolitical situation or infrastructure problems (Ciais et al., 2021). These difficulties constitute a challenge and, at the same time, an impulse to describe not only temporal states - current or momentary, but also to conduct analytical work in the context of the probability of specific events in the future based on available historical data (Matthew et al., 2020).

Another problem is collecting useful and comparable data. In the analyzed case, there were also areas (expenditures on education, research and development) that required interpretation. This in turn can affect information distortions, despite the comparability of data (Table 1). A proposal that limits the problem posed in this way is multi-criteria analysis, which is

necessary to determine the current state and possible future states. Only then will it be possible to plan actions that really aim at improving the areas studied.

Conducting an analysis of the initial state in order to indicate areas that should be included in the comparative analysis, but also to determine the method of measuring and assessing the state described by a given criterion requires both reliable data and a correct procedure (Rostkowski, 2019). Therefore, a useful and aggregated set of data is necessary (Human Development Statistical Annex, 2019) on the basis of which analyses can be conducted in correlation with the adopted research assumptions. This allows for the study of the dynamics of changes occurring in the indicated time periods (Table 1).

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	Germany	0,936	81,2	17	14,1	46136	4
19	Japan	0,909	83,9	15,2	12,8	38 986	19
-	Very high	0,894	79,5	16,4	12,2	40 041	-
27	Czech Republic	0,888	78,9	16,9	12,7	30 588	27
33	Poland	0,865	77,8	16,4	12,3	26 150	34
38	Slovakia	0,855	77,0	15,0	12,5	29 467	39
45	Hungary	0.838	76,1	15,1	11,9	25 395	45
-	Europe and Central Asia	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.

Comparative analysis allows for highlighting a number of dependencies, while illustrating - necessary for the proper conduct of the synthesis process - the connections and complexity of these connections. Here, one can also conduct considerations regarding the reference of the situation of the examined object to the background in the context of complexity, ambiguity, uncertainty and dynamics of the changes taking place (Staruch, 2019). This is to enable a correct description of existing dependencies. Since the processes are dynamic and take place over time, and the connections are assessed post factum, indicators that clearly describe the changes taking place will be necessary. Therefore, the conclusions resulting from the conducted analyses may be burdened with uncertainty. Consequently, this may exclude them from further work. Hence the proposal to supplement the analytical work with a time approach. In this way, it will be possible to exclude some of the indicators as unsuitable for further analytical work. Therefore, the analysis should be conducted, so that it is possible to demonstrate the dependencies in relation to the issue being examined. Comparative multi-criteria analysis is a proposal to balance the uncertainty accompanying the inference, but only on the condition that the analytical work is properly conducted, taking into account their staged nature (Bernat, 2023).

Analytical work should, if possible and certainly justified, include clearly defined time frames indicating regularities occurring there (Lachowski, 2019), including trends or tendencies describing changes occurring or their absence. This in turn requires searching for indicators reflecting the suggested perspective of looking at the analyzed phenomena or objects. In order to obtain a more complete picture of the studied process or state, it is necessary to collect information from many different, and above all reliable and objective, and therefore verifiable sources (Bernat, 2019), which is a challenge for researchers at the stage of preparing assumptions for analytical work.

3. Interpretational distortions

Comparison of aggregates such as GDP or GNI, inflation, unemployment or employment (https://www.money.pl/gospodarka/wskazniki/pkb/, 2019) levels enables both analysis of the social situation and assessment of economic prospects. Importantly, these prospects can be scaled over the years or selected research periods, thus describing in a dynamic approach the changes taking place, e.g. economic changes describing market behavior, but also differences between the objects or phenomena studied or emerging interpretational discrepancies. Fig. 1 shows an example of presentation of data included in Table 2 concerning unemployment. In turn, the data included in Table 3 concern inflation.

Table 2.
Unemployment as of 1.11.2019 - data for figure 1a

Indicator	Date	Value [%]	Annual change in %
unemployment	1.11.2019	5,10	-13,56
number of unemployed	1.11.2019	849600,0	-13,72
new unemployed	1.11.2019	122500,0	-70,45

Source: Money.pl, unemployment, https://www.money.pl/gospodarka/inflacjabezrobocie/#, 31.03.2020.

The data in Tables 2 and 3 are presented in different analytical approaches. In the case of both unemployment and inflation, the annual percentage changes are estimated on a reference basis, and therefore describe the relational dependencies and not the actual state of the analyzed issue, hence, for example, referring to annual changes described in percentage terms highlights the large amplitude of these changes, which, however, is not confirmed by the analysis of the course of the studied phenomenon, as shown in Fig. 1.

Table 3.

*Inflation as of 1.11.2019 - data for figure 1b*

Indicator	Date	Value [%]	Annual change in %
Inflation I	1.11.2019	2,60	+52,94%
Inflation II	1.11.2019	0,10	-66,67%
Inflation III	1.11.2019	2,50	+400,00%
Inflation IV	1.11.2019	2,20	+83,33%

Source: Money.pl, unemployment, https://www.money.pl/gospodarka/inflacjabezrobocie/#, 31.03.2020.

As it results from the analysis of the information content of Table 3, it is necessary to provide a definition of the indicator in order to be able to relate it to the current situation in the context of the changes taking place. Thus: inflation I is defined in relation to the same month of the previous year, and inflation II in relation to the previous month, while inflation III in relation to December of the previous year. Inflation IV, in turn, is the average annual inflation indicator, i.e. the average of inflation I from the last 12 months, and hence, i.e. from the method of measuring the indicator, such dynamic, and presented in Table 3, annual changes in percentage terms.

The differences between the data in Table 3 and Figure 1b are explained by the definitional description of the indicator, i.e. in this case the way of defining inflation itself and showing the value of the indicator (2.2%) or the changes taking place (+83.33%) - here in annual terms. It is similar in the case of unemployment (compare Table 2 with Figure 3a. Therefore, analytical data can describe the situation in a longer time perspective, as shown in Figure 1, but also illustrate relational dependencies, i.e. in a specific interpretational approach as presented in Tables 2 and 3. And only the comparison of the information content in the appropriate time period, taking into account the definitional content of the indicator, shows the proper perspective for assessing a given phenomenon. In the analyzed example, this concerns unemployment and inflation.

Indicators that aggregate several variables, such as HDI, seem to be more important from the point of view of assessing future states, e.g. of the economy, but also of the quality of life of society - because they have greater information and interpretation potential - which confirms the assumptions of the comparative multi-criteria analysis. Since the Human Development Index (HDI) reflects the quality of life, in this case (Table 1) we get a social space described by three dimensions: a) health, b) education and c) standard of living. Thanks to the data prepared in this way, we can observe and compare changes over the years and their dynamics (Human Development Reports…, 2019).

a) unemployment   b) inflation
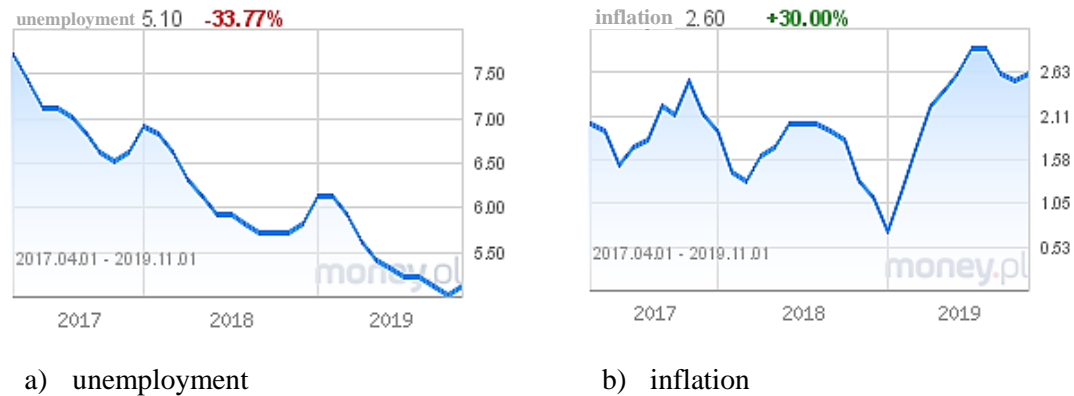
Figure 1. Unemployment and inflation comparison.

Source: Money.pl,   unemployment,   https://www.money.pl/gospodarka/inflacjabezrobocie/#, 31.03.2020.

There are also significant differences due to the measures used. In the case of the HDI index, gross national income (GNI) per capita was used. This significantly reduces the ranges that are visible when using GDP as a measure. It is also important whether we conduct the considerations in relation to purchasing power (PPP). Then the differences can be as much as 189% (Bernat, 2023), and this can cause various distortions and consequently discrepancies interpretation. For the reasons mentioned above, the Gini coefficient itself will also be useful for illustrating the changes taking place. Therefore, the assessment requires a set of comparable criteria reflecting the situation within the adopted time period, which determines the purpose of the work, which comes down to both needs and interpretation possibilities. Here, we can talk about a "periodic" time analysis. However, in addition to examining the time and amplitude of the phenomenon - as described above - we can also conduct research on the frequency and trends of changes taking place. This requires further work and indicators that allow for comparative analysis.

4. Conclusions

Comparative multi-criteria analysis is a proposal resulting from the research assumption indicating the necessity of conducting a directional analysis based on the research background in order to enable an indicator assessment that meets the interpretation needs. Interpretation possibilities in turn result from the adopted assessment criteria. Hence, considerations conducted in the form of analytical comparative works, aimed at demonstrating existing similarities, connections or problems and their correlations or finally interpretational distortions, seem to be the most beneficial analytical approach providing a number of useful, reliable and, equally importantly, comparable data.

The use of useful and recognized, and therefore commonly used indicators such as: GDP, HDI or locally developed, such as IOR - the indicator of responsible development or IZR - the indicator of sustainable development will be an acceptable way of assessing the issue under study, corresponding to the assumptions of comparative multi-criteria analysis. This then allows for reference to the environment, i.e. research background, which systematizes the assessment, directing further analytical work aimed at describing - within the concept of mutual interactions - possible or potential connections, dependencies and interactions.

The research work concerned determining a useful analytical procedure by taking into account the time factor manifested by local stable states. Further work will aim to include trends in the conducted analyses as determinants of ongoing changes.

The starting point of the conducted considerations was a quantitative comparative analysis aimed at a narrative comparative analysis, hence the difficulties in collecting appropriate cases. Narrative analysis takes into account the context of the event and the results for a given case. This allows - on the basis of reference, i.e. taking into account the context - to interpret the findings understood as recommendations. Ultimately, the recommendation and direction for further work will be a cross-analysis, so that we can interpret the similarities and differences of the issues studied. This will highlight the factors influencing the result, and with a time perspective, the next step will be to include trend analysis as the basis for further research. Using multiple data sources and methods allows for triangulation of information, and thus reducing its uncertainty, ambiguity and complexity by eliminating interpretational distortions.

Comparative analysis, the purpose of which is to describe the phenomena taking place or to demonstrate the current state of the object being studied against the background of the reference, aims to demonstrate dependencies or discrepancies with the description of the actual state. It is also necessary to take into account interpretational distortions – differences – related to the information, the content of the presented indicators or the specific time perspective of the analyses conducted. Both verifiable data and the correct procedure are elements necessary to implement the research assumptions, i.e. a description, the purpose of which is to demonstrate the presence or absence of connections and interactions, and thus correlation or their absence, which requires designating a) areas of analysis, b) defining measures necessary to assess the state of the described objects and phenomena, c) many criteria, because only then can the considerations be conducted contextually. In a broader context taking into account amplitude, time and frequency. Capturing and highlighting existing differences makes it possible to improve the interpretational adjustment, and more importantly, to limit interpretational distortions.

The temporal approach of the issues studied allows for the recognition of the dynamics of changes taking place and minimizing distortions, and consequently differences in interpretation and their impact on the final assessment and recommendations.

Comparative indicator analysis based on aggregated data enables the description of the issue, taking into account the needs, but also the possibilities of interpretation. The credibility of the information obtained results from both the adopted indicators and the research background. Taking into account the temporal approach allows for searching for interpretational discrepancies, which can be an element of further analytical work. Indicator analysis based on aggregated data improves efficiency, but also reduces interpretational discrepancies, which is particularly important in the context of searching for probable future states of the objects or phenomena being studied.

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