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Attractiveness Assessment Model for Evaluating an Area for a Potential Geopark—Case Study: Hațeg UNESCO Global Geopark (Romania)

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Abstract: Many studies have developed methods for assessing attractiveness, but the question is which one should be used to evaluate geopark designated areas? Therefore, the aim of this study is to find suitable criteria for assessing the attractiveness of a natural area such as a geopark in order to find the best quantifiable method as a methodological guide to evaluate attractiveness. The principle of the methodology takes into account three facts: the use of available attractiveness methods elaborated over time, the UNESCO Global Geoparks (UGGp) geopark requirements, and a certified geopark (Hațeg UNESCO Global Geopark was chosen as etalon—benchmark), then matching these together. To this end, the following specific objectives have been set: (i) an inventory of factors used to estimate attractiveness; (ii) through analysis, identifying the appropriate evaluation criteria for the field (a set for criteria's SMART parameter, which can be clearly expressed, quantitatively measurable, and achievable); and (iii) developing a methodological guideline for geopark attractiveness assessment. The methodology is based on an analytical thinking approach, builds on the experience of existing methods, and stands out by the attributes matched to the UGGp's evaluation criteria using the certified geopark as a benchmark. The result itself presents a method for assessing the attractiveness of geoparks. The outcome offers the attractiveness suitability for new geopark-designated areas as well as for existing geoparks aspiring to UNESCO certification.

Keywords: geopark assessment; attractiveness evaluation model; UNESCO Global Geopark; SMART criteria; attractiveness; methods; methodology development; benchmark attractiveness index; geopark; UNESCO certification aspiration



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1. Introduction

As the world's population grows and the Earth's resources are challenged by change, the need for sustainable protection arises. In the field of tourism, this protection takes many aspects, one of which focuses on the development of geoparks, which enjoy some of the highest levels of protection for natural destinations. As defined by UNESCO Global Geoparks, UNESCO Geoparks, together with the other natural and cultural heritage elements in the area focusing on land, life, and people, use geoheritage to raise awareness and understand the main issues facing our society, such as the sustainable use of the Earth's resources, mitigating the effects of climate change, and reducing the impact of natural disasters [1]. Every year, the number of Geoparks is growing; the main reason for this is

the protection and sustainable development of the area concerned [2]. Although 195 geoparks [1] in 48 countries have been created so far, the world still has a large potential area in which to implement them. In only two decades, this number of UNESCO geoparks grew quickly under the protection of the UNESCO Global Geopark Network (GGN), dating from 2004 when the agreement with European Geoparks Network (EGN) was signed [3].

Everywhere in the world, in both national and international contexts, in order to make the most of a region's tourist heritage, it is important to know its value for its exploitation and development. To do this, first of all, it is necessary to assess its attractiveness potential; several quantitative evaluation methods have been developed for this over the years. This is not a simple matter, as it cannot be "weighed" in an international quantitative unit of measurement, and there will always be a dose of relativity and subjectivity. Therefore, while many evaluation methods have been developed, the degree of relativity of the results can be flawed due to the difficulty of measuring attractiveness [4]. The limiting factors are, on the one hand, the typological complexity of tourism resources, and on the other the difficulty of quantitatively assessing qualitative expressions.

In terms of literature review the researchers worldwide have considered the attractiveness of tourist objects or areas in different taxonomic dimensions and in different ways over many decades. Decade by decade, the assessment of attractiveness indicates a subject of particular interest, especially in the last ten years (Figure 1).

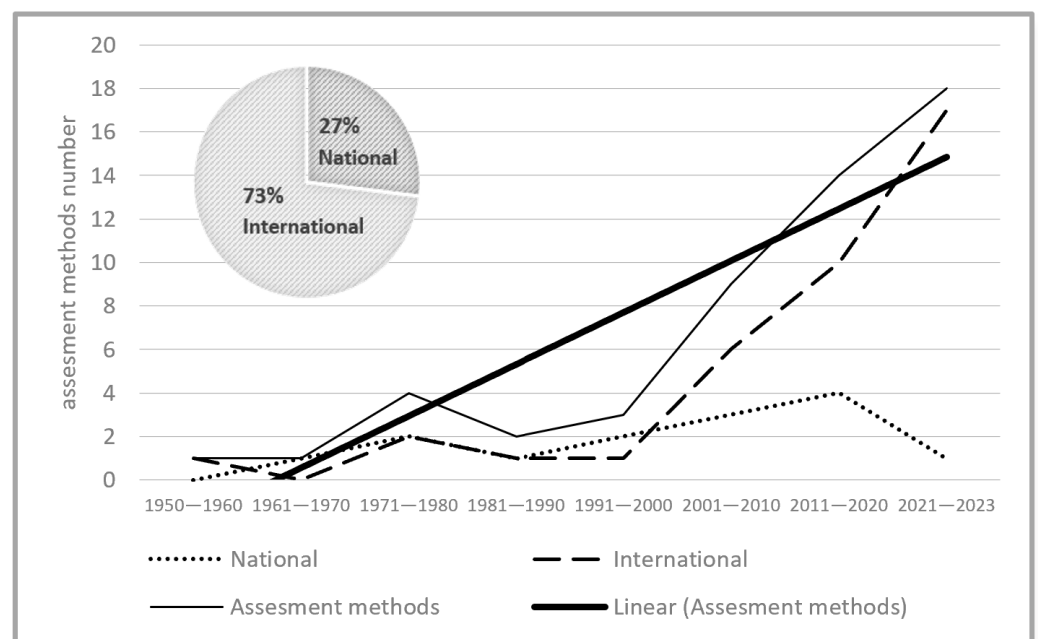


Figure 1. A composite edit showing the process of developing assesment methods (the line graph) and the national/international ratio (the pie chart) between 1956 and 2023.

Positive linear growth in the number of studies can be observed in the graph, with an appreciable jump between 2021 and 2023. In addition, a great deal of research has involved the development of different tools or of other complementary scientific branches.

In analysing this research, the common idea is that the attractiveness of a destination is provided by criteria presented as attributes or as components with certain parameters, with the relationship between them often expressed by mathematical formulas.

The type of attributes chosen is a decisive factor in the outcome when determining the attractiveness of a destination. Researchers have described the role of destination attributes [5]. The perceived attributes starting with tourist attractions [4] and end with the different levels of attraction for investment [6,7] or with quality indicators such as structural quality, ecological quality, and management quality [8]. Other quality variables include the quality of the country's promotion, information, accommodation, and restaurants [9].

Tourist attractions are the driving force behind tourists visiting a destination, and are defined by richness of natural and socio-cultural potential with attractive value; others have commonly agreed on tourism attractions [10], tourist resources [11,12], or tourist physical features [13].

Beyond the main features of attractiveness, namely, natural or man-made resources, accessibility plays an important role; researchers have often expressed accessibility from the same or from different perspectives. Other investigated topics include the accessibility of tourism destinations and access roads shown to be accessible in relation to the main tourist-generating regions or countries [4,14–16]. Furthermore, accessibility has been expressed as communication potential [17], accessibility based on principles of accessibility levels [18], transport accessibility [7,11], and the meaning of accessibility as proximity to tourist areas and proximity to main communication factors (road, airport, river etc.) [19].

In terms of methodology, some studies have relied on different types of information used: geospatial data [8], remote sensing data [20], data from national geodatabases, and cartographic resources [7]. Others have considered collection methods such as sampling and survey methods, with questionnaires being the main instrument for the collection of data in these studies [11,21,22]. Finally, most studies have been founded on methods regarding the processing of the collected data. The Gołembski index (multivariate comparative index) and Wejchert's Impression Curve Method were used to obtain the visual impression of the landscape [6,7]. Other methods are based on GIS approaches: GIS combined with checklist [13], developing assessment models to measure geodiversity using QGIS [23], cartographic analysis [24], spatial analysis, and hot spot analysis with ArcGIS [25]. Attractiveness has also been described using the concept of links through a method based on link analysis [26] or with the combined approach of Analytic Hierarchy Process (AHP) with a Fuzzy Comprehensive Evaluation Method (FCEM) [14]. Others have applied the Analytic Hierarchy Process (AHP) to assess attractiveness [19], applied indicators analysis using a methodology related to landscape quality (LQ) [20], or performed a quantitative analysis [27,28]. Further on, there are mathematical methods [29–31] and the SMAA and PROMETHEE method [32]. The statistical analysis used is represented by regression analysis [33,34]. Other approaches include the evaluation matrix for criteria [35], multidimensional statistical techniques [36], SWOT analysis [37], application of IPA [38], comparing RDA+CPA versus IPA [39], and the probabilistic travel model [40,41].

We can state that the mathematical expressions are mostly linear [4,42]. They express the weighted relationship between attractiveness segments and the importance of the criteria, such that the ranking is made by the weighted method. Many researchers have established scoring systems [12,43] or included a weighted method [18,19]. The geopark theme [44,45], the destination geoheritage assessment point of view, and the assessment of certain areas for possible geoparks [46] have been considered as well.

The destination has various forms and different taxonomies in the studies: nature-based tourism areas [32,47,48], rural areas [12,49,50], rural–urban areas [51], mountains [11], cultural heritage sites [19], regions with attractiveness for tourism and recreation to facilitate regional planning [52], attractiveness for sustainable forest recreation tourism [42], comparison of regions with the same characteristics [53,54], national parks and assessment of geotourism areas in mountains [55,56], urban areas [57,58], and areas with geomorphosites [59].

Looking more deeply, researchers have considered a wide variety of case studies. While pointing to different objectives in their studies, they have agreed that tourism destinations have a number of variables from destination to destination. Thus, among others, different reviews covering modelling and mapping show that attractiveness assessment for geoparks is not quantified and mapped.

Therefore, the main aim of this study is to develop a model for assessing the attractiveness of a natural area intended to be a geopark in terms of attractiveness. This attractiveness suitability model has to be useful for decision-making in the geopark planning process. To achieve the desired result, the following objectives were set:

- i. Inventory of factors used in previous methods to estimate the attractiveness.
- ii. Through analysis, identifying the appropriate evaluation criteria for the field as a set for criteria's SMART parameter, which can be clearly expressed, measurable quantitatively, and achievable (SMART means specific, measurable, achievable, relevant, and time-bound).
- iii. Developing a methodological guideline for assessing geopark attractiveness.

2. Materials and Methods

2.1. General Framework

The principle of the methodology is based on three pillars. The three main segments are: methods, checklist, and certified geopark. The evaluation model was constructed based on these segments. For the development of the study, the primary data we used were taken from these three pillars (Figure 2). These data and the secondary data needed to calculate the parameters were used to carry out the developed process, that is, the methodology for integrating them into an overall attractiveness score.

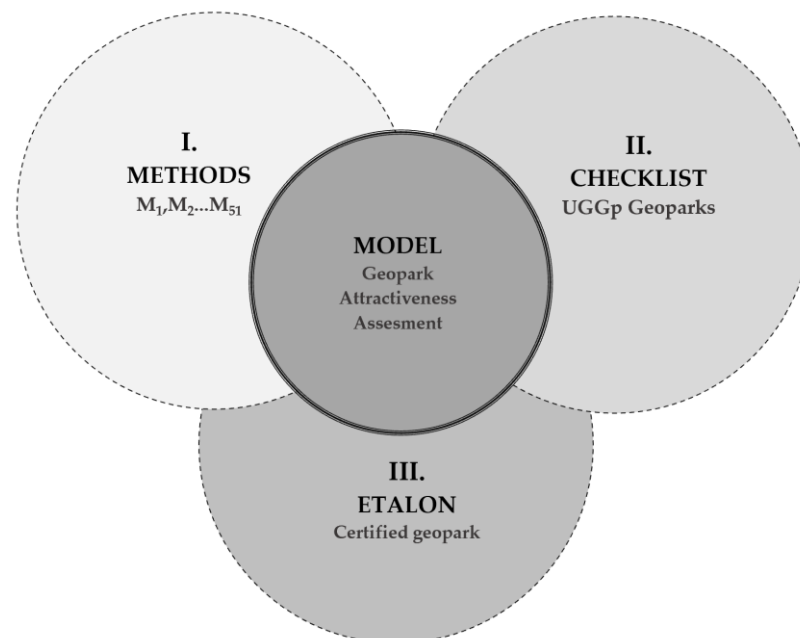


Figure 2. The methodological principle is based on three pillars or three dimensions: (I) pillar with all the evolution methods that were considered in the study; (II) pillar with the UGGp geopark evaluation checklist; (III) pillar with a certified geopark.

The basic concept of the methodology was to select from among the various attractiveness features used in the research those that meet the criteria described in the Global Geopark status. These criteria for UNESCO Global Geopark designation are established in the evolution checklist called the Self Evolution Form (Form A) [60]. The methodology for the attractiveness assessment has been developed based on this concept, which was implemented in five steps.

In the first step, data collection, the attractiveness methods used in studies over time were collected along with information about geopark evaluation documents and data about the certified geoparks. This further revealed the characteristics used to determine attractiveness found in methods, followed by an inventory of criteria. The second step, analysis, consisted of the analysis of method items defined to evaluate the attractiveness, with the purpose of consolidating the matching process between methods attractiveness criteria and evolution checklist criteria. The third step, establishing the criteria, included the correlation process between the criteria on both sides. We matched the appropriate attributes from studies with the geopark criteria to find the most suitable criteria and

attributes for the designated geoparks. The fourth step, defining the parameters, involved the quantification of the criteria parameters using specifications and references from other qualified geoparks as a benchmark. Finally, the fifth step, building the system that express the criteria relationship, consisted of creating the model, setting up the relationships between attributes, and calculating the attractiveness index (Figure 3).

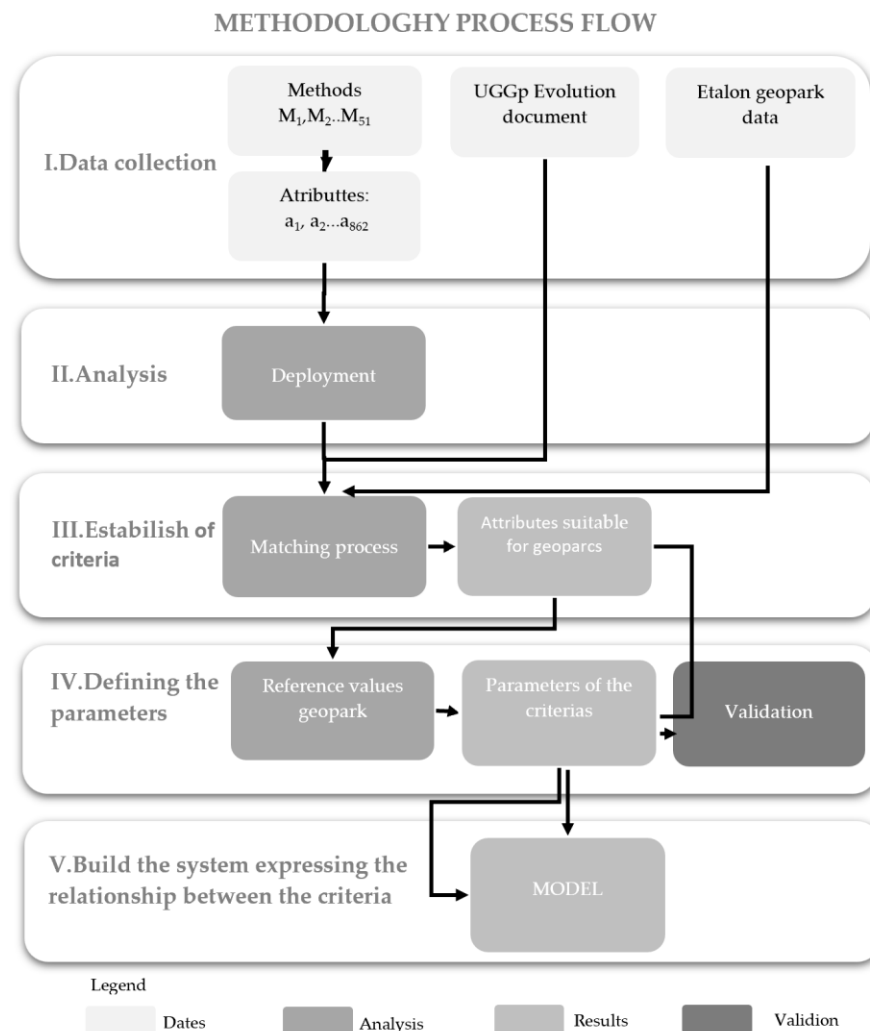


Figure 3. Process flow of the methodology procedure: (I) data collection; (II) analysis; (III) establishing criteria; (IV) defining the parameters; and (V) building the system and creating the model.

Data collection began as part of the first stage of the process. The research was based on 52 scientific papers, which mostly consisted of studies of natural destinations (national parks, geoheritage, mountain destinations, landscapes) as well as tourist locales (resort areas or regions, village tourism, city tourism), nature-based tourism, recreation, and tourism. The set of factors from the methods used were collected from each study and analysed further; as there were 52 studies, 52 methods were applied for assessment.

2.2. Analysis of Data from the Evaluation Methods

The starting point of the data of the study was the attractiveness methods and their components. The analysis was carried out to understand the main concepts of the data used in different studies. The information from these methods required deeper analysis as the methods diversified, as this increased both the number of factors considered as important and their complexity. For this reason, we followed the deployment analysis method.

Deployment Analysis

Deployment is the process of analysing a topic, issue, etc., and developing a plan to implement actions. Deployment analysis is often used as a tool to provide support for a specific goal in management for Key Performance Indicators, as well as in engineering, to deploy machine components [61] or indicator components to improve performance [62]. The purpose of deployment analysis is showing the detailed focused elements in aggregated form along with the relationship between them in order to consolidate the selection of attributes and their matching processes. The items of attractiveness methods, that is, the criteria, are classified and summarised in Figure 4.

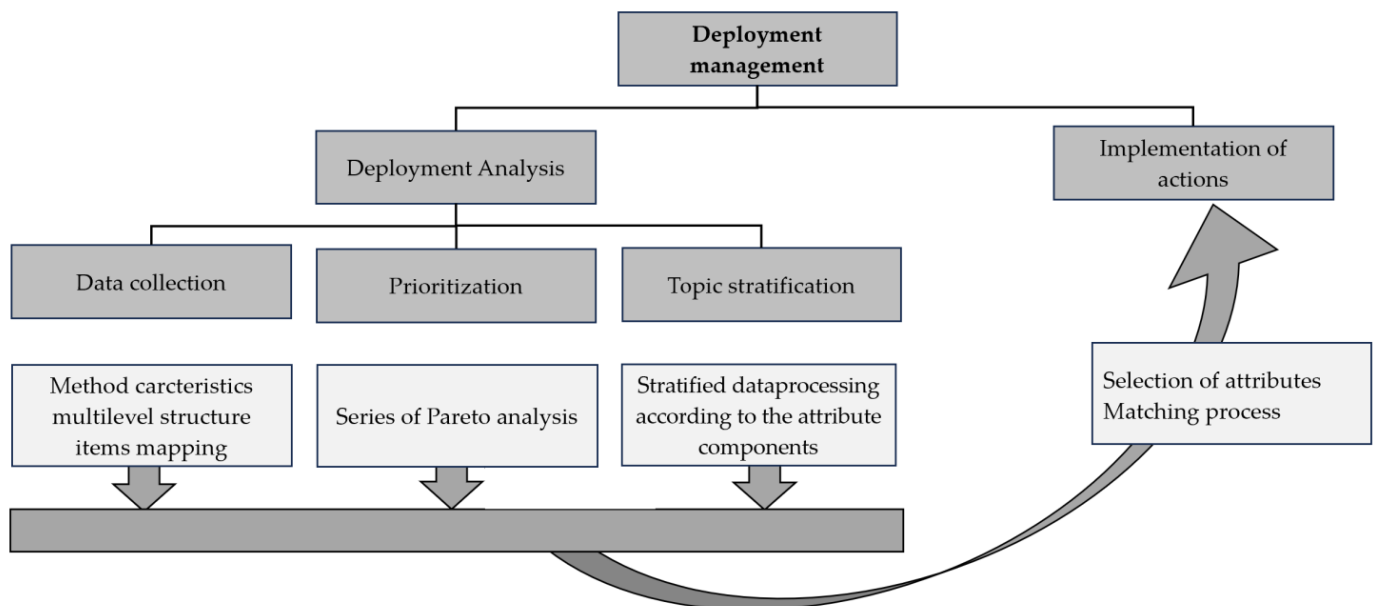


Figure 4. Deployment process adapted for tourism.

Due to the interest of researchers in attractiveness assessment and the variety of methods and techniques (52), we had the opportunity to create a solid database containing a high number of items, which were turned into in a large inventory of criteria; in total, 862 attractiveness attributes were inventoried. Along with the high interest in attractiveness assessment, the diversification of analysis techniques over time (e.g., surveys, statistics, GIS [10,63,64]) has increased the complexity of items finally available to us. The large and complex inventory of items ensures a better quantification of attractiveness in order to come as close as possible to an objective result.

Research methods have demonstrated development and diversification in analysis techniques. Methodologically, starting by collection of data types and followed by processing methods, collection methods include observation, inventory-taking, sampling, and surveying, with questionnaires as the primary instrument. Questionnaires may use a Likert-type scale (i.e., endpoint descriptions from 1—very low to 5—very high) [28,30,32,37,65]. The variety of data processing methods can be categorized into the following groups: (a) statistical analysis (13); (b) mathematical analysis (11); (c) points role-based method (11); (d) GIS analysis (6); (e) Importance Performance Analysis (IPA) (3); SWOT analysis (1); and (f) combined methods (7).

Over the past decade, there has been an expansion in the use of cartographic, statistical, and mathematical techniques. The complexity in the last group is notable, with multiple tools and techniques being combined. Prominent combined methods include: 1. Gołembski index—multivariate comparative index and Wejchert's Impression Curve Method [6]; 2. Golemski method with modification and correlation analysis [7] where the Gołembski method is used for multidimensional comparative analysis.; 3. Analytic Hierarchy Process (AHP) with Fuzzy Comprehensive Evaluation Method (FCEM) [14]; 4. analysis

based on remote sensing data and correlation [20]; 5. spatial analysis and spatial statistics (including hot spot analysis) [25]; 6. Relevance–Determinacy Analysis (RDA), Competitive Performance Analysis (CPA), and Importance Performance Analysis (IPA) [39]; and 7. the SMAA and PROMETHEE method (the SMAA method, developed for discrete multicriteria problems with imprecise criteria values, weights, or other model parameters, complements the PROMETHEE method, which is suitable for analyzing single decision factors) [32]. Regarding the software used in methodological analysis, statistical programs are widely used (e.g., R Core 2014, SPSS Statistics 20, STATISTICA 13.1), alongside the GIS-based platforms ArcGIS and QGIS for spatial data analysis and geographical visualization.

However, this study primarily focuses on the set of criteria and evolution of variables used in these methods over time. The different processing methods applied to these variables are crucial to ensure their usability. An analysis of these methods was conducted on a set of criteria, which are referred to as “variables” due to their categorization into various levels (e.g., level 1 category natural resources, level 2 subcategory, level 3 elements).

The methods present a multilevel structure to evaluate attractiveness for a certain type of taxonomy. The number of levels of classification has not changed significantly, as in the past the average was 1.80 with a level range between 1 and 3, and later it remained almost the same at 1.85, with a minimum of 1 and a maximum of 3. The number of items used by the methods increased from an average of 12 to an average of 23 in the last ten years, for an increase of 88% over the last ten years compared to the period before 2014. The lowest number of attributes contained in the method used for the tourism potential was two [4], while the highest was sixty [11], described to evaluate the attractiveness and competitiveness of the Romanian Carpathian Mountains Destinations (Table 1).

Table 1. Structure and characteristics of methods over time.

#	Characteristics	1956–2013	2014–2023	Total
1.	Total methods inventoried	25	27	52
2.	Average number of classification levels	1.80	1.85	1.82
3.	Average number of items used per method	12	23	18
4.	Total attribute inventoried	311	551	862

In the next phase, the most used classification categories were analysed with Pareto diagrams. Typically, Pareto diagrams are useful because they are a tool that shows the relative importance of data, providing a summary of practical information [66]. This analysis reveals the most commonly used categories in the field. The objective of this step is to determine which common attributes were used by different researchers. The most important factors that contribute to an effect deserve the most attention [67]. Of course, one notable point is that many researchers have agreed on a comprehensive conceptual framework for assessing the attractiveness of tourism potential.

The amount of 862 items inventoried was divided into 334 types, meaning that several items were used in two or more methods. In the Pareto chart developed for attractiveness attribute by category, the first 15 elements in the graph are the most chosen variables used in the 52 research methods (Figure 5).

The first column of the chart, natural resources, contains 73 attributes. The natural resources are followed by accessibility, with a value of 52, and the third place is occupied by the anthropogenic resources, which are 47 in number. The first column, natural resources, includes components related to morphologic (18 in total), hydrographic (16), biogeographic (32), and climatic tourism resources (7).

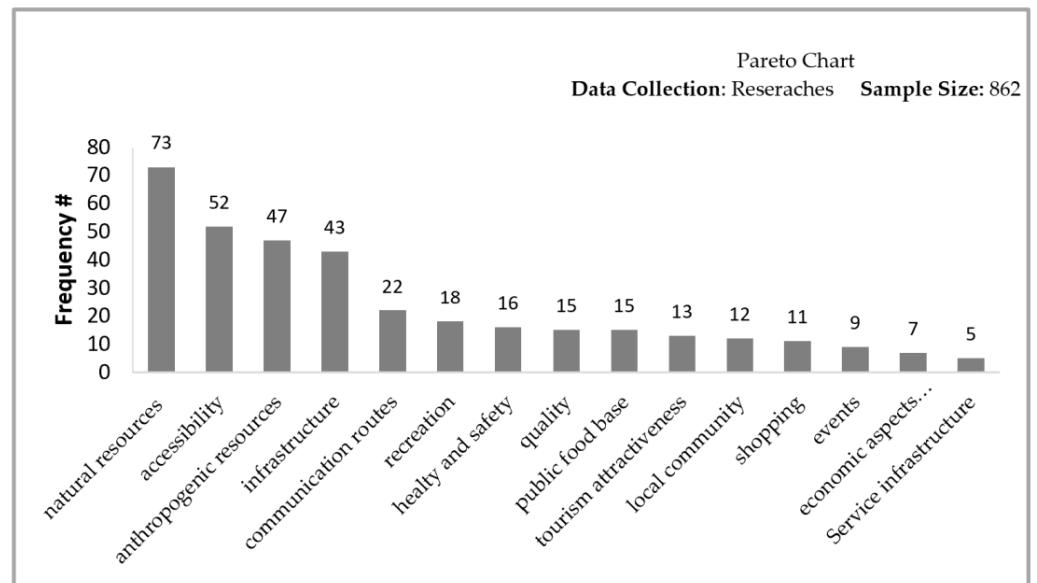


Figure 5. Comparison of the first fifteen category using a Pareto diagram.

The second conclusion from the analysis shows that the first level of the classification, natural resources, includes the most important factor. Tourism heritage is composed of natural resources and man-made resources, with natural resources playing an important role as factors influencing the development of tourism [68]. When moving from the general (natural resources) to the next level, there is disaggregation into components (Figure 6).

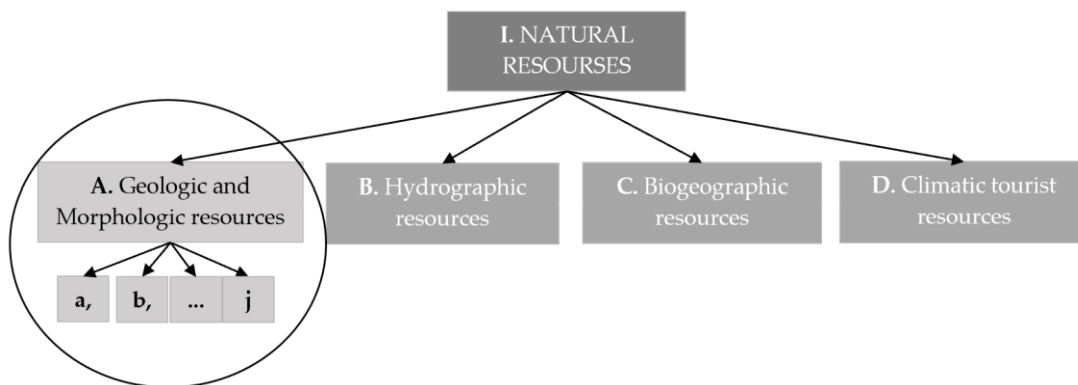


Figure 6. Deployment for the first level of natural resource characteristics.

The attractiveness component of different resources (A–D) was summarized and all their items were brought together for further effective action. As an example, one of them, the natural morphological resources, is presented here. The geological and morphological resources components applied in previous studies are synthesized in categories and subcategories (Table 2).

Table 2. Geologic and morphological resources components (A); deployment from natural resources segment. Items and the relationship among multiple observed variables.

Subcategory	Elements
(a) the geologic and morpho-touristic fund	1. rocks, minerals and fossils 2. morphological components
(b) the morphological factor of tourism (the relief)	3. mountain 4. hill 5. depression 6. littoral
(c) relief factors with tourist value	7. caves 8. valleys gorges
(d) relief structure data	9. volcanic relief 10. glacial relief 11. on crystalline schist data 12. relief on conglomerate limestone and sandstones 13. geomorphosites on limestone/conglomerates
(e) structural quality indicators	14. forest area (Proportion of land covered by forest) 15. arable area 16. land cover diversity (Shannon diversity index)
(f) touristic value	17. unique monuments (local, regional, national, international) 18. number of natural monuments size, physiognomy, age, function, structure
(g) quality factors/Scenic/aesthetic values	19. unspoiled natures/scientific beauty 20. beautiful Landscape 21. quality of sandy beaches 22. lush vegetation 23. dramatic landforms (e.g., flat and hilly lands)
(h) quantitative factors	24. number of objectives with the same characteristics 25. grouping of elements in the territory expressed by levels of concentration or dispersion 26. spatial distribution 27. number of natural monuments
(i) number of connections	28. inlinks (the number of inlinks of the scenic spot) 29. outlinks
(j) Protected Area Network	30. special protection areas 31. sites of community importance 32. reservations, protected natural areas, national parks

As an overview, these items and categories were pointed out to measure the attractiveness for the studied area in terms of morphological segment. For the morphological segment carried out, we counted 11 categories (a, b. . .j) and 32 elements developed through all studies. A number of these were used by several authors, such as caves [11,13], while others were used by only one author, i.e., arable area [6] and quality of sandy beaches [21].

2.3. Setting the Criteria, Attributes, and Parameters

The third step, establishing the criteria, includes the correlation process between the criteria on both sides. The question is which of the many attributes collected so far from various studies are suitable for estimating the attractiveness of a geopark; these attributes have to meet the UGGp [60] requirements as well. A globally applicable checklist developed by UNESCO outlines these requirements. The decision has to be based on the criteria derived from the geopark requirements and the attributes collected from the studies. Thus, the factors outlining the attractiveness of a geopark were determined by a matching procedure. The scope of the matching process is to bring out those items suitable for a geopark from the inventoried attributes. Thus, the final set of criteria was selected through

a consensus decision-making process based on 334 attributes extracted from the studies and criteria derived from the geoparks description. The matching process was carried out in a logical decision matrix (Figure 7a,b).

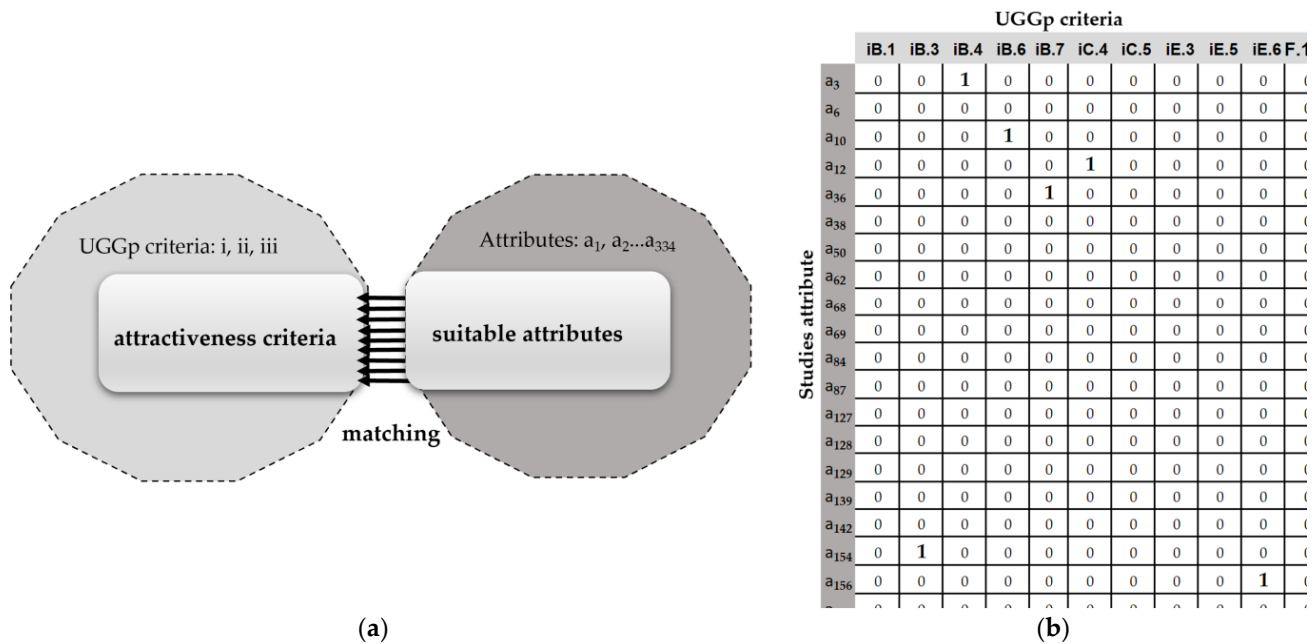


Figure 7. (a) The UGGp form assessment criteria (in the left), attractiveness related criteria (the grey segment), attributes from the studies (in the right), not all of which are suitable for a geopark (grey area). (b) Decision Logical Matrix. Boolean logic scale 0, 1 (1 = yes, 0 = no).

The matching process was made in a logical decision matrix, where the scale was a Boolean logic scale 0, 1 (1 = yes, 0 = no), meaning that a value of 1 is suitable for assessing the attractiveness of a geopark and a value of 0 is not suitable. The logic of this process is illustrated in the scheme Figure 7a, which shows how some of the attributes were transformed into UGGp criteria. In addition, it shows that not all of the attributes were taken to express geopark attractiveness criteria and not all geopark criteria involved attractiveness (Figure 7a).

It can be seen that the most commonly used attributes from our database are concentrated on one side (Figure 7b) and the geopark description criteria are concentrated on the other side. The result of the matching process provides 27 attributes through which the geopark attractiveness criteria can be expressed. A thorough analysis of the attributes and the process of matching between the two types of data resulted in a final set of criteria that can be used for assessing the attractiveness of a geopark.

With the criteria established, the following fourth step was undertaken to determine the value of the parameters. Few researchers used scientific expertise or expert opinions in the field, while others relied on interviews or questionnaires. For this, we decided to use the etalon concept. The etalon, or reference standard, “is the standard of the highest quality available in a given place or organization” [69]. Etalon is a perfect model of a standard measurement; it is made with great precision and officially accepted as a basis for comparison. It is widely used in the scientific and technical fields, especially in the exact sciences [70].

Because in this case the UGGp certification can be considered a standard level, it can be affirmed that it represents the etalon in the field, serving as basic unit in a system of measuring criteria. Thus, the solution is to take a UNESCO-certified geopark as a reference by using it as the etalon (benchmark), firstly, because these geoparks meet all the requirements, having been assessed for certification, and secondly, because they are periodically assessed every four years.

The Hațeg County UNESCO Global Geopark, certified in 2015, evaluated several times, and recently recertified in 2023, was taken as the etalon in our study. For the quantitative establishment of the parameters in numbered values, the UNESCO certified geopark parameters values were taken as an ideal situation represented as a standard figured out by measurement units specified according to the chosen model. This numerical method aimed to reduce the subjectivity of the evaluation to ensure that the result was as accurate as possible.

Etalon Reference Area—The Hațeg County UNESCO Geopark

The etalon geopark was represented by the Hațeg UNESCO geopark. This geopark was included in the Global Geopark Network (CGN) in 2005 and designated as a UNESCO Global Geopark in 2015. The Geopark has been periodically reassessed five times, in 2008, 2010, 2014, 2018, and 2023.

The geopark is located in Romania, Hunedoara County, has the coordinates 45°36'27" N, 023°22'44" E, covers 1124 km², and lies near the main European roads E 68 (connecting Hungary, Romania), E 70 (Spain, France, Italy, Slovenia, Croatia, Serbia, Romania, Bulgaria, Turkey, Georgia), and E 79 (Hungary, Romania, Bulgaria, Greece).

In terms of relief, the geopark covers a tectonic sedimentary Carpathian basin, a wide part of the Hațeg Depression, partially extending to the surrounding mountains Poiana Ruscă, Țarcu, Retezat, and Șureanu. Tectonically, the basin is already identifiable at the end of Cretaceous. A consequence of the tectonic subsidence of a Precambrian and Paleozoic metamorphic and magmatic area, it passed through an archipelago of islands stage during the upper Cretaceous, finally having a constant sedimentation from the Jurassic to the Pleistocene. Volcanic rocks (tuffs and lavas) and craters marking the eruptions that took place during Jurassic and Cretaceous are documented. The high area over the Țarcu Mountains were affected by the quaternary glaciations, and glacial valleys and cirques have been identified there. The anthropogenic relief consists of old quarries and a closed copper mine.

The last stages of the upper Cretaceous consist of continental fluvial and lake deposits, with chelonia, crocodilia, and dinosaur fossils; other reptiles (even flying reptiles), birds, and early mammals have been discovered there as well. Specific to this area are the dwarf dinosaurs, including more than ten species of herbivorous and carnivorous dinosaurs, known worldwide as “the dwarf dinosaurs of Transylvania”, as well as dinosaur eggs and hatchlings. Their small size is due to the environment they lived in: a tropical island of only about 200,000 km² with limited food resources. However, one of them (*Hatzegopteryx thambema*, “the winged monster of Hațeg”, with a 2 m long skull and a 12 m wing span) was perhaps the largest flying animal ever. *Elopteryx nopcsai* was a small dinosaur 1 m high and 5 kg in weight carnivorous that hunted in packs; some consider that its body may have had feathers, meaning that it might have been the first fossil bird in Romania. The main herbivorous dinosaurs were *Telmatosaurus transsylvanicus*, a 3.5–4.5 m long dinosaur living in vicinity of the rivers, and *Struthiosaurus transilvanicus*, a 2–3 m long dinosaur defended against predators by the bony plates and spines on its skin [71,72].

In order to qualify as a geopark, a region must have a geological heritage of international importance highlighted by its contribution to scientific research and educational value and by its outstanding natural beauty. The stages of implementing a geopark are geopark status, aspiring geopark status, and finally certified UNESCO geopark status. However, in order to qualify for the highest status a number of conditions prescribed in the UNESCO Global Geopark checklist must first be met. Hațeg Geopark has passed through these phases, being certified in the first wave of UNESCO certified geoparks in 2015. In fact, any UNESCO geopark meets the ideal geopark conditions. Moreover, this geopark status can only be maintained through a revalidation process every four years based on criteria set by the Global Network of Geoparks and UNESCO commissions, as had the geopark chosen in the study. We chose this geopark to develop the model because it has passed through all the formative stages and has met and continues to meet the very high

requirements for recognition as a UNESCO site. At the same time, it satisfies the prescribed requirements, as demonstrated by its diversity of parameters and internationally important scientific value.

3. Results

The variables have been performed on the basis of the criteria defined in the various studies and the requirements of the geoparks in order to determine the attractiveness of the destination. In applying the methodology, the selection of criteria for evaluation is as important as the evaluation itself. While criteria play a very important role in determining attractiveness, it should be noted that defining criteria can sometimes involve a subjective approach [73]. In the matching process, the selection involves a careful analysis of the given case studies in order to combine them in terms of their geopark attributes. First, attributes that did not correlate with the geopark requirements, of which there were a large number from other studies, were removed (matching process, 0 category). Then, priority was given exclusively to reference quantifiable form parameters, as they reflect a reference point, that is, an ideal situation.

Based on this, the study resulted in 27 attributes that can be used to assess the attractiveness of a geopark. Out of 334 variable types, 27 attributes were matched to the checklist criteria. These had to meet two conditions: first, to fit the profile of the checklist, and second, to be quantifiable, as one of the objectives of the study was to choose the SMART indicators (specific, measurable, achievable, relevant, and time-bound) for the geoparks. This was done to eliminate the eternal problem of assessing attractiveness only with indicators that are appreciable. In fact, many of these 334 variables can only be appreciated by awarding points or attributes (such as satisfactory, good, very good, etc.) or based on levels. At the same time, there is a wide range among the attributes that covers the quality of the accommodation structure in its various categories. The resulting suitable attributes can be seen in Figure 8 as A_1 , evidenced by palaeography and range of geological periods, as well as a_{154} [44], linked to the UGGp criteria iB.1. However, it can be noticed that not all of the inventoried criteria items are listed (334), as not all of them fit the UGGp criteria. This is because the non-conforming items were given a value of 0 on one side due to the matching process, while on the other side only the attractiveness-related UGGp criteria were used (Figure 8).

In addition to these, six attributes had to be added to the resulting set of attributes required to express the geopark's attractiveness-related criteria. This meant that although much work has been done on the subject in the past, the attributes defined thus far do not fully cover the criteria for a geopark area. This is because, on the one hand, they are geoparks, and on the other hand, because they have not yet been defined, for example, a geological map (A_{19}) or other kind of map that has not yet been defined, as well the World Heritage attractions. The World Heritage sites are a special kind of place that serve as the main purpose for certain segment of tourists.

Having obtained the final set of attributes (33) for the attractiveness evaluation, in the next phase the parameters and metrics were settled on the etalon concept. The main property of the parameters is that they are quantifiable and express an ideal situation or benchmark that is reflected in the Hațeg County Global Geopark values defined as a reference.

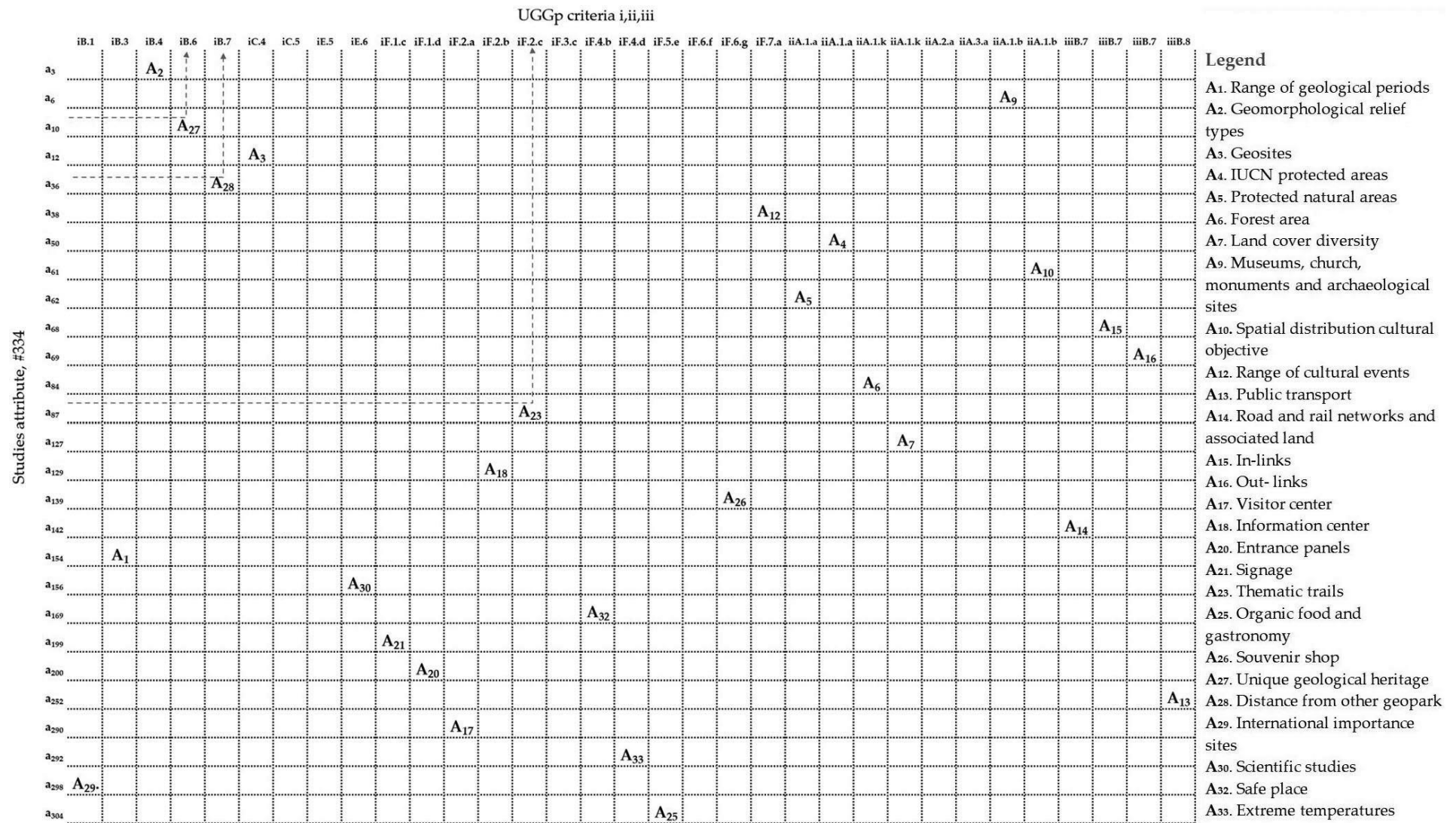


Figure 8. Attributes matrix resulting from the matching process, showing Link Attractiveness Model attributes with study attributes and UGGp criteria.

3.1. Building the Model

Next, the model was built based on the defined variables and their parameters. It is configured in segments, criteria, and attributes that structure, given by the membership criteria and related to the segments described in the UGGp document, while additionally considering the categories found in the deployment analysis. It is structured on three levels consisting of 33 defined quantifiable attributes (Table 3).

After collecting the attribute values for all datasets related to the Hațeg Geopark UNESCO World Heritage Site, the next step involves their calculation, standardization, and weighting. These values then become intermediate composite indicators. Subsequently, these indicators are aggregated to form a singular comprehensive measure called the Attractiveness Index (A_I). This index encapsulates the overall value of the geopark's attractiveness attributes. The result for the UNESCO Geopark in Hațeg County calculated A_I stands at 0.94 based on intermediate indicators (standard value). This score provided by the model reflects the significance of the Hațeg Geopark, highlighting the benchmark value.

The model in our study is structured in nine distinct segments: Geodiversity; Biodiversity; Tangible Cultural Heritage; Intangible Cultural Heritage; Accessibility; Infrastructure; Singularity (Rarity); Scientific Value; and Safety and Risks. Each segment is aligned with the UGGp criteria and classified according to the outcomes of deployment analysis. Below, we detail these segments, outlining the types of analysis conducted within each, the parameters employed, and the sources of data used.

Table 3. Quantitative expressed evaluation criteria model of the attractiveness assessment for a geopark.

Segment	Criteria	Attribute	Parameter and Units of Measurement	Etalon Value	Standard Value	Weight Factor
Geodiversity	C ₁ . Paleography	A ₁ . Range of geological periods	Number of geological period [# / km ²]	0.008	1	0.0286
	C ₂ . Relief structure data	A ₂ . Geomorphological relief types	Number of items [# / km ²]	0.006	1	0.0286
	C ₃ . Protected areas	A ₃ . Geosites	Number of geosites [# / km ²]	0.018	1	0.0571
Biodiversity	C ₄ . Natural reserve	A ₄ . IUCN protected areas	Number of items per km ² [# / km ²]	0.009	1	0.0286
		A ₅ . Protected natural areas (parc national etc.)	Proportion of land covered by protected nature areas [%]	38.16	1	0.0286
	C ₅ . Structural quality indicators	A ₆ . Forest area	Overlay [%]	53.13	1	0.0143
		A ₇ . Land cover diversity	Shannon Diversity Index (H)	1.032	1	0.0143
Tangible cultural heritage	C ₆ . Manmade buildings	A ₈ . UNESCO World tangible cultural heritage site	Number of cultural heritage per km ² [# / km ²]	0.001	1	0.0571
		A ₉ . Museums, church, monuments and archaeological sites	Number of cultural heritage per km ² [# / km ²]	0.08	1	0.0286
	C ₇ . Grouping in the territory	A ₁₀ . Spatial distribution	Density of cultural point groups at d = 1 km [# / km ²]	0.027	1	0.0286
Intangible cultural heritage	C ₈ . Traditions	A ₁₁ . Intangible cultural heritage and traditions protected at national level/international	Number of items per km ² [# / km ²]	0.003	1	0.0571
	C ₉ . Events	A ₁₂ . Range of cultural events	Type of events/year [# / year]	4	1	0.0286
Accessibility	C ₁₀ . Transport	A ₁₃ . Public transport (Road and rail)	Number of trips/day/destination [# / day / location]	3.95	1	0.0143
		A ₁₄ . Road and rail networks and associated land	Proportion of land covered by network areas [%]	1.17	1	0.0143
	C ₁₁ . Number of connections	A ₁₅ . In-links (inside territory)	Number of trips/day destination [# / day / location]	10	1	0.0143
		A ₁₆ . Out-links (outside territory)	Number of trips/day destination [# / day / location]	0.51	1	0.0143
Infrastructure	C ₁₂ . Public information infrastructure(s) on the territory	A ₁₇ . Visitor center	At least 1 / area	6	1	0.0286
		A ₁₈ . Information center	At least 1 / area	5	1	0.0286
		A ₁₉ . Geologic map	1 / area	1	1	0.0286
		A ₂₀ . Entrance panels to the territory	Number of items [#]	1	1	0.0286
	C ₁₃ . Signposting	A ₂₁ . Signage along the roads and/or at important sites	Density of signage [# / km ²]	0.043	1	0.0286
		C ₁₄ . Routes	A ₂₂ . Sustainable car-free routes	Length of carefree route per geopark territory, Density [km / km ²]	0	0
	A ₂₃ . Thematic trails		Sum of trails length geopark territory, Density [km / km ²]	0.3	1	0.0143
	C ₁₅ . A wide range of excursion offers	A ₂₄ . Range of tours (geotourism; ecotourism etc.)	Number of items [#]	4	1	0.0143
C ₁₆ . Gastronomy	A ₂₅ . Organic food and gastronomy (bioproduct-geoproduct and local gastronomy)	Type/number [#]	3	1	0.0286	
	C ₁₇ . Shopping	A ₂₆ . Souvenir shop	Number of shops [# / km ²]	0.001	1	0.0286
Singularity (Rarity)	C ₁₈ . Rarity of geoheritage	A ₂₇ . Unique geological heritage	Number of sites	1	1	0.0857
	C ₁₉ . Geopark	A ₂₈ . Distance from other geopark	Distance > 100 km	163	1	0.0286

Table 3. Cont.

Segment	Criteria	Attribute	Parameter and Units of Measurement	Etalon Value	Standard Value	Weight Factor
Scientific value	C ₂₀ . International value of the geological and cultural heritage	A ₂₉ . International importance sites (with international recognition or international publications)	Number of items [# / km ²]	0.004	1	0.0571
	C ₂₁ . Research	A ₃₀ . Scientific studies	5-Within the past five years Sum of academic research: books, articles, academic papers [#]	10	1	0.0286
		A ₃₁ . PhD thesis	1-Within the past three years	0	0	0.0286
Safety	C ₂₃ . Security of the site	A ₃₂ . Safe place	Incident frequency: Number of incidents/accidents/1000 visitors	0	1	0.0286
	C ₂₄ . Risk	A ₃₃ . Extreme temperatures (Natural hazard)	Deviation from average temperature [°C]	26	1	0.0286
			Benchmark Attractiveness Index	=	0.94	

3.1.1. Geodiversity

Geodiversity is “the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features. It includes their assemblages, structures, systems and contributions to landscapes” [74]. It is the central resource of geoparks used for scientific, educational, and tourism purposes. Thus, the range of geological periods, diversity of relief types, and number of geosites and protected natural areas are important assets for their effective exploitation. A wide range of geological periods influences all the other criteria through the variety of layers and rocks. For this geopark, eight geological periods were identified using the geological maps. One of them, Cretaceous in its upper part (Maastrichtian), has layers consisting of continental fluvial and lake deposits with volcanic products, and stands out due to its palaeontological findings. While the dinosaurs (Dinosauria) are the most prominent, there are vertebrates, fishes (Pisces), amphibians (Amphibia), reptiles (Reptilia), birds (Aves), mammals (Mammalia), and many invertebrates (snails, shells, insects, small crustaceans) as well [72]. The relief types are the result of both geology (structural, petrographic relief) and the geomorphological agent (fluvial, glacial, periglacial, anthropogenic relief). Their identification was made using the topographic and geomorphologic maps. Including the geological and geomorphological areas of interest in geosites or protected natural areas is the first step for their scientific, educational, and tourism exploitation. The information we used was taken from the databases of Hațeg and of the Romanian Ministry of Environment.

3.1.2. Biodiversity

Biodiversity conservation efforts worldwide are concentrated in protected areas [75]. Because their surface and objectives vary by country, region, type, and objectives, for our evaluation we chose the IUCN categories for defining the number of reservations/km² criteria. The forest area, important both for biodiversity and recreational tourism, is defined by legislation (excluding other wooded land), and was measured according to the governmental geospatial databases. The Land cover diversity indicator was rated using the ESRI Land Cover Explorer and Shannon Diversity Index [76].

3.1.3. Tangible Cultural Heritage

Tangible cultural heritage includes manmade buildings of scientific, educational and architectural value that are also part of tourist heritage, such as museums and historical monuments (buildings and sites that received a special legal status intended to protect it for their historical, architectural, technical or scientific interest; castles, fortresses, churches, archaeological sites). The density of the cultural point groups parameter was calculated using the QGIS 3.22 geographical information system and applying the DBSCAN clustering tool (the algorithm requires two parameters; the minimum cluster size was 1 and the maximum distance allowed between clustered points was 1 km).

3.1.4. Intangible Cultural Heritage

Intangible cultural heritage represents the practices, representations, expressions, knowledge, and skills, along with all the tools, objects, artefacts, and cultural spaces associated with them, that communities, groups, and in certain cases individuals recognize as part of their cultural heritage and strive collectively to live, recreate, and transmit. This living heritage derives from the 2003 UNESCO Convention for the Safeguarding of Intangible Cultural Heritage (ratified by Romania in 2005 and implemented by the Ministry of Culture). Three elements were inventoried in first attribute, two of them from the social practices, rituals, and festive events category (Sânzienele, Sântoaderul) and one included in the traditional craftsmanship category (Ia, the traditional shirt)

3.1.5. Accessibility

Accessibility is mainly linked to transport infrastructure and the number of connections [77]. Transportation links nodes that often serve as access points to intermediary

locations [78]. In this study, the main settlement of the geopark is considered as the main node connecting the geopark to the outer area through public transport. The indexes resulted from the inventory of the total number of public transport destinations situated outside the area reachable from this node. For access in the area of the geopark, the indicator consisted of the proportion of land covered by network areas and the in-links connecting the main node to the intermediary locations through public transport.

3.1.6. Infrastructure

Geopark infrastructure is the asset through which their educational and tourist value reaches visitors. Therefore, the presence of visitor and information centers, souvenir shops, the touristic geologic map, and panels and signage are important criteria in the assessment. As a local version of travel itineraries, car-free trails, thematic routes, and food and gastronomy itineraries [79] are essential for tourism.

3.1.7. Singularity (Rarity)

An aspiring UNESCO Geopark first and foremost requires geological uniqueness with geotourism potential [80]. Thus, when surveying the tourism objective a researcher must first check how the objective responds to five attributes: age, uniqueness, originality, size, and function fulfilled [4]. There are two parameters: unique geological heritage [81], which refers to the form, size, or flow (in case of springs) along with fossils and/or rare lithology [44], and distance from a geopark. The site of Tustea has the status of world rarity due to remains of hatched chicks being discovered next to nests with eggs.

3.1.8. Scientific Value

This indicates the scientific importance of the site as presented by the amount of research carried out, level of academic research activity, and recognition of the site. This segment includes three attributes. International importance sites are the following scientific reserve status sites: Ohaba Ponor fossil site, Sânpetru fossil site, Reptilian fauna Tustea, and the UNESCO Church of Densus [82–86]. The Tustea, Sânpetru, and Pui sites are of international importance due to the large number of scientific articles published in ISI indexed journals, some of them reporting discoveries of new taxon. The other attributes are scientific studies [87–90] and PhD theses. For the parameters, the data sources were the databases of journal platforms (WoS, ResearchGate, Google Scholar) and the educational platform REI for doctoral theses [91].

3.1.9. Safety and Risks

The main condition for the normal development of tourism in a destination is peace; therefore, safety and security are basic determinants of its growth [92]. Another significant factor is risk. The destination risk perception of tourists directly affect their decision-making [93,94]. Security is correlated with incidents that may occur in a certain place. Due to this, a safe place was defined in this study. On the risk side, meteorological risk [44] in the form of extreme temperatures was taken as a factor that bothers visitors and may have a disturbing impact on geological forms or nature resources. The data were taken from the National Centers for Environmental Information [95] and calculated for the period 2022–2023 (sample size 3403). The statistical analysis was performed with the Tukey method [96], with extreme values detected using the interquartile range method, where values outside the range ($Q1 - 1.5 IQR$, $Q3 + 1.5 IQR$) were considered extreme values. For extreme value detection, the fences were at $-16\text{ }^{\circ}\text{C}$ and $36\text{ }^{\circ}\text{C}$, resulting a data series with a median of $10\text{ }^{\circ}\text{C}$.

The calculated data were partially validated with the final development results of the geopark or the value of another certified geopark. A number of the parameters did not require a validation process, such as the distance to another geopark.

3.2. Criteria Relations: Mathematical Expression

In terms of the ranked relationship of the criteria and parameters for the attractiveness assessment, after the appropriate criteria and parameters for the attractiveness assessment were established, a ranking of the pair of criteria in relation to the reference value was defined to the maximum score in the geopark evaluation form. This involves defining a weighted relationship between the categories.

For each parameter, standardization is expected before weighting and combining its values following the methods for different situations (1 or 0).

The evaluation criteria are based on two types of parameters; one type increases the attractiveness of the evaluated site, while the other lowers it. For this second type, usually measuring threats present in the region, higher measured values should be turned into lower ones in order to correctly assess attractiveness (e.g., a lower number of incidents/accidents implies higher attractiveness). This can be easily done using the reciprocal value of the original.

The final attractiveness value will be the possibly weighted linear combination of these transformed/normalized parameters using the following formula (Equation (1)):

$$\sum_{i=1}^n w_i \cdot p_i \quad (1)$$

where w_i is the weight of parameter p_i .

Due to the fact that weights can be chosen quite subjectively in these situations, some studies prefer to use equal weights [97].

To ensure further developments of the methodology expanding with other parameters, the previous liner combination can be transformed into an average value.

3.3. Benchmark Attractiveness Index

The model is materialised by an indicator called the Benchmark Attractiveness Index, which represents the attractiveness value for a benchmark geopark. After calculating the mathematical expression of this value, the result of the attractiveness assessment for the Hațeg Land Geopark shows a Benchmark attractiveness index of 0.94. This means that in terms of attractiveness this value is the benchmark. According to the gap analysis, the failure to reach the maximum value of 1 is due to two indicators in the infrastructure segment: the attribute “sustainable car-free routes”, and the scientific value attribute “PhD theses”.

The benchmark index is a well-defined measured value that can be used as a standard for other destinations and against which the destination result can be compared [98]. This means that the current level of attractiveness for an area designated as a geopark can be determined using the model. If the assessment results in a benchmark level, it means that the territory is suitable for a geopark area in terms of attractiveness. If the value does not reach the desired level of benchmark attractiveness value, a gap analysis can be conducted. In this case, the gap analysis [99] has to be done between the benchmark index value (the ideal situation is forecast based on the benchmark) and the current index value.

4. Discussion

4.1. Implications of Research Findings

Attractiveness is an “engine” for tourists, a power of destination; Formica mentioned that Kaur thought that “the attractiveness is the drawing force” [100]. Attracting tourists is a crucial aspect of any destination’s success, as tourist attractions form the cornerstone of the tourism industry [101]. These attractions not only draw visitors but also play a significant role in shaping the local economy, preserving cultural heritage, and enhancing community identity. The measuring tool for the power of attractiveness of the destination should always be based on a set of criteria [102].

First, this study is focused on a preventive conception to make life easier for others. Previous studies have not applied a preventive thinking approach for destination areas. Moreover, developing a model to assess the attractiveness of an area in order to determine whether it is suitable for a geopark is a new approach. The main result of this study is a model for attractiveness which can serve as a tool in decision-making process. It can strengthen the planning and decision-making processes by focusing of the best suitable place for a touristic destination in terms of attractiveness. In contrast, various other attractiveness models have been developed in different contexts. For instance, one mathematical model [30] focuses on calculating the probability of a tourist choosing a specific destination. Another model [41] adopts a probabilistic approach to travel oriented towards the accessibility of tourist infrastructure. Additionally, a model [103] has been built specifically to assess the attractiveness of forest destinations.

Second, this study contributes to understanding the criteria and the systems of criteria used in previous studies, as proven by the large number of the 862 variables we inventoried as part of the 52 methods analysed; in fact, the number of variables almost doubled compared to the previous period. Despite this, the analyses we carried out revealed that the attributes estimated by the methods used by other researchers do not fully cover the expression of a geopark's attractivity. The reason for this is that past studies most often used so-called traditional attributes [104]. Early researchers were especially focused on tourist attractions [101] as natural resources, as well as on anthropogenic resources and infrastructure [12,19]. Instead, the last decade has seen changes due to the diversity of methods applied. Thus, a new category of attributes has emerged, for example, a focus on safety and security [14,64,105] in various forms (such as the feeling of security [37], feeling of personal safety [9], peacefulness [38], security of the site [44]), which were applied in this study as well.

Finally, this study focused on 33 attributes of attractiveness, 27 of which were derived from previous studies. The reason for using the researchers' experience was because these variables have been previously demonstrated in several case studies and by many researchers. Several of them appeared many times in scientific papers. This ultimately provided us with a solid database. The conceptualization described above adopts an approach similar to that [28,32]. In these studies, the criteria (attributes) for assessing tourism attractiveness in protected areas and destinations were established based on their respective analyses of relevant research papers [28,32]. In this study, the attributes were systematically linked to a checklist, enhancing the thoroughness of our assessment approach.

As already mentioned, the variety of criteria has increased sharply over the last decade, mainly due to the extension of analytical methods and the diversification of techniques. In this study, the process of managerial analysis and the deployment and logical decision matrix, which have not been used before in this subject, were adopted; even in tourism more generally we have not encountered them yet.

Third, the study focused on quantifiable parameters, most of which are not very hard to calculate and easy to replicate. The model presented in this paper demonstrates that a methodology for quantifying the attractiveness of a destination can be defined by measurable parameters expressed in numbers, thereby filtering out subjectivity. Due to the difficulty of finding suitable parameters for indicators, in previous research the parameter values were mainly drawn from a set of questions asked via survey [11,13,19] or were built by experts using a point system [12,55]. An example is the six quantifiable parameters which used data sourced from the National Institute of Statistics to assess attractiveness for a city destination based on tourism indicators [57]. By comparison, in this study we defined 33 quantifiable parameters.

The fact is that the attractiveness value depends on criteria, that is, on its number and parameters. It can be affirmed that using more criteria brings us closer to the reality, as demonstrated by the ever-increasing number of variables used in studies per method in the last decade. Truly, every evaluated type of area has its specificity. For this reason, the attractiveness factors should always be adapted to the type of destination of the area.

4.2. Limitations and Future Research Direction

Limitations may appear in the safety parameter field, as in the geopark area there were no incidents or accidents found, which is really the ideal situation. However, it may have been the case that there were no registered data; this could be an issue in the future. Therefore, data collection may be a vulnerable point.

Another limitation of the study is that there was no tolerance range size value, which can be considered in a following study. Further research steps are planned, and our next purpose is a case study of attractiveness assessment for an area where a geopark can be implemented. Applying the model may result in some modifications. Further research as part of a larger study could aim to resolve any inconsistencies that may have arisen.

As a new possibility (horizontal expansion), the benchmark idea could be applied in other forms of tourism taxonomy where there is an example that can be taken as a benchmark. This model may have applicability in the case of measuring a particular destination as a benchmark and then comparing it with some changes in the criteria. It is important to retain the three pillars: I. studies criteria; II. criteria settled by a high level of organization (e.g., UNESCO); and III. benchmark object/destination.

5. Conclusions

The principle of the methodology is based on three pillars, in which the main segments were the following: available attractiveness methods elaborated over time, geopark evolution checklist, and certified geopark. After the methodology was carried out, the result determines the attractiveness through an attractiveness model expressed in a result by the Benchmark Attractiveness Index. Summarizing the main results of the study are the model mapping, determined by the attractiveness criteria and related benchmarks. In detail, the conclusions are as follows:

- (1) Based on an analysis of the methods developed over time, we found 52 methods to measure attractiveness used for different ranges of taxonomy, mainly nature-based areas. These were inventoried along with the factors used, providing us with a large amount of data and a total of 862 variables.
- (2) The deployment analysis method was used to analyse the methods and components used by different researchers for assessing attractiveness. The types of categories and variables used were prioritized, i.e., 334, where the most used repetitive variables being traditional attributes. The distribution pattern of the methods became more complex in the last decade, with the average number of used items reaching 23 per method.
- (3) To express geopark attractiveness, the UNESCO requirements for geoparks were linked to the attractiveness determination criteria through analysis to identify the appropriate evaluation criteria for this domain of geoparks. We established the relationship between the methods through the attributes, identified the attributes that influence the determination of the attractiveness, and drew the model.
- (4) When setting the parameters, we focused on those which could be clearly expressed and were measurable by a quantitative number. The attribute parameters were based on etalon data. The Hațeg Land Geopark area data represented the etalon data, as it has had Global Geopark status since 2015.
- (5) The model was materialized by an indicator named the Benchmark Attractiveness Index, which is an attractiveness value for a benchmark geopark. Territories aiming to establish themselves as geoparks can use this model to assess their attractiveness and perform a gap analysis, leading to informed corrective actions. The “gap” in the gap analysis process refers to the space between “where they are” (the present state) in terms of attractiveness and “where they want to be” (the target state or desired state).

The model’s target taxonomy consists of natural areas for which the sustainable development plan is to become a geopark. The model itself provides a method that can be applied globally for an area destined to become a geopark in the future as a preventive action. A key aspect of this research is related to the UNESCO checklist, which

is a document developed for global use all over the world on any territory, country, or continent. Consequently, the model's applicability is not confined to a specific area or origin, demonstrating the global utility of the UNESCO checklist (e.g., Brazil, Norway, Japan). In addition, the factors have a solid basis and have been used in at least one study. Our research has taken this approach with the aim of using it effectively and displaying its potential wider relevance.

The study itself has a certain uniqueness, as presented in the deployment analysis adapted for tourism for dates and methods analysis, in the assessment model including negative factors, and in using the etalon concept (parameters set according to a chosen reference as the etalon or benchmark), and in the final Benchmark Assessment Index indicator of the model.

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