

Global Research Trends in the Analytic Hierarchy Process (AHP), 1980-2026: A Bibliometric Study*

Anna PRUSAK¹ and Patrycja CITAK²

¹Department of Process Management, Krakow University of Economics, Kraków, Poland,
ORCID: 0000-0002-8344-658X,

²Krakow University of Economics, Kraków, Poland

Correspondence should be addressed to: Patrycja CITAK, citakp@uek.krakow.pl

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Abstract

The Analytic Hierarchy Process (AHP) is one of the most widely applied multi-criteria decision-making methods and has been extensively used across numerous scientific disciplines since its introduction in 1980. The objective of this study is to examine the evolution, dissemination, and thematic development of AHP research through a large-scale bibliometric analysis. The study is based on a dataset of 50000 journal articles published between 1980 and 2026 and extracted from the Lens.org database. Bibliometric techniques implemented in the R environment were used to analyze publication trends, geographical distribution, publication sources, research fields, and author-defined keywords. Thematic developments were investigated using alluvial diagrams based on *Fields of Study* and keyword metadata. The results reveal a continuous and accelerating growth of AHP-related research, with publication output increasing from 179 papers in the 1980s to more than 23000 papers in the still incomplete decade of the 2020s. The findings demonstrate the highly interdisciplinary character of AHP, which is currently applied across thousands of research fields and increasingly integrated with sustainability assessment, GIS technologies, fuzzy approaches, risk analysis, and artificial intelligence-related methods.

Keywords: Analytic Hierarchy Process, AHP, bibliometric analysis, multiple criteria decision making, MCDM

Introduction

The Analytic Hierarchy Process (AHP), one of the most frequently used MCDM (*multiple criteria decision making*) methods, was developed in the 1970s by Thomas L. Saaty on the basis of his work at the U.S. State Department's Arms Control and Disarmament Agency during the Kennedy and Johnson administrations. In that time, Saaty recognized that existing approaches to complex decision-making problems lacked both sufficient mathematical rigor and practical applicability to real-world situations. Subsequently, he proposed a new theory of measurement supporting decision makers in dealing with multi-criteria and highly complex problems. His early research focused on structuring decision problems by organizing them into hierarchical models oriented toward specific goals. He proposed pairwise comparisons as the core element of the method, allowing experts to evaluate the relative importance of criteria and alternatives on the basis of their judgments. These comparisons are then used to derive priority scales and determine the relative weights of decision elements. The mathematical foundations of the method were established using eigenvalues and eigenvectors, which enable the calculation and verification of the obtained priorities (weights). These weights make it possible to comprehensively evaluate and compare decision alternatives by reflecting their relative importance with respect to all considered criteria. As a result, decision makers are able to prioritize available options and identify the most preferable alternative (INFORMS 2008, Saaty 1980, Saaty 2008).

Since the publication of Saaty's seminal book *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation* (1980) - often regarded as the foundational work and "bible" of the AHP methodology - the method has become one of the most widely applied approaches to decision-making problems worldwide (Vaidya and Kumar 2006). Its broad applicability is reflected in the large number of scientific publications employing AHP across diverse research areas, including i.a. management, engineering, environmental sciences, healthcare, transportation, energy planning, military and public policy. Due to the enormous number of AHP applications published over the past decades, discussing individual studies separately would be neither practical nor sufficiently representative. A more meaningful approach is to conduct a "review of reviews" by referring to the numerous literature reviews that summarize AHP applications across different research domains and periods.

One of the earliest compilations is *The Hierarchon: A Dictionary of Hierarchies* (Saaty and Forman 1992), which contains over 400 decision problems from government, industry, healthcare, military strategy, planning, and private-sector contexts, each structured as a hierarchical AHP model that can be adapted to support complex decision-making processes. Other general and cross-disciplinary reviews of AHP applications include, *inter alia*, the studies by Vaidya and Kumar (2006), Sipahi and Timor (2010), Ho and Ma (2018) or Khan and Ali (2020), which collectively demonstrate the extensive use of AHP across numerous scientific and practical domains. A somewhat different example in this context is the study by Mardani *et al.* (2015a) and Mardani *et al.* (2015b), who reviewed a broad range of applications of MCDM methods rather than focusing exclusively on AHP. Nevertheless, their analysis demonstrated that the AHP - together with its extension, the Analytic Network Process (ANP), also developed by Thomas L. Saaty - were among the most frequently applied methods in the literature compared with others, such as TOPSIS, DEMATEL, ELECTRE, PROMETHEE etc. (Mardani *et al.* 2015a, p. 524).

At the same time, the literature also offers many review papers focused on specific disciplines and application areas of AHP, such as business and management (Subramanian and Ramanathan 2012, Matějčiček and Marešová 2025), human resources (Salehzadeh and Ziaecian 2024), construction engineering (Darko *et al.* 2019), healthcare (Liberatore and Nydick 2008, Schmidt *et al.* 2015), sustainability studies (Santos *et al.* 2019) and energy planning (Pohekar and Ramachandran 2004). The above-mentioned papers are systematic literature reviews covering from several dozen to several hundred individual studies published over periods of up to two decades. An interesting example in this context is provided by studies covering substantially larger numbers of publications and broader time spans, such as Emrouznejad and Marra (2017); unlike traditional review papers, this study uses bibliometric (in this particular paper referred to as "scientometric") and social network analysis techniques in order to quantitatively analyze publication patterns, co-authorship networks, and thematic evolution within AHP research. Their dataset included 8441 works within the years 1979-2017, divided into three sub-periods: 1979-1990, 1991-2001, and 2002-2017. An even larger-scale bibliometric analysis was conducted by Madzik and Falát (2022), who examined 35430 documents related to AHP published between 1980 and 2021 and retrieved from the Scopus database. The authors extended the scope of "traditional" bibliometric analysis by grouping publications into research areas using the Latent Dirichlet Allocation (LDA) topic-modeling approach. This enabled them to examine the evolution of AHP research interest over four decades, analyze its dissemination across different scientific disciplines, and investigate the thematic development of the field over time.

The objective of the present study is to conduct a bibliometric analysis on an even larger body of AHP-related scientific literature, covering the period from 1980 - corresponding to the formal beginnings of AHP - up to the present year, 2026, although the latter period is still ongoing. The analysis was based on a dataset of approximately 50000 metadata records extracted from the [Lens.org](https://lens.org/) database (Jefferson *et al.* 2018). In order to ensure the comparability of the analyzed material, only scientific journal papers were included in the dataset, while other publication types - such as books, dissertations, book chapters, conference proceedings, and editorial materials - were excluded. It should be noted that the total number of AHP-related records in the database would be substantially higher if these additional document types had also been taken into account. To analyze the evolution of research trends and the interdisciplinary dissemination of AHP over time, alluvial diagrams were employed using the open-source R programming language and its bibliometric and data-visualization capabilities.

The AHP procedure

The purpose of this section is not to provide a comprehensive methodological description of the AHP, as numerous comprehensive studies are available (e.g., Saaty 1980; Prusak and Stefanów 2014; Kułakowski 2020). Instead, only a brief overview of the method, its underlying principles, and its main procedural stages is presented to provide readers unfamiliar with AHP with the necessary methodological background.

The AHP process begins with defining the decision problem, specifying the objective, identifying decision alternatives and evaluation criteria. Proper problem formulation is fundamental because it determines the quality

of the subsequent analysis and enables the decomposition of the decision problem into a hierarchical structure (Saaty 1980; Ishizaka and Labib 2011). These elements provide the basis for constructing a hierarchical model that decomposes the decision problem into progressively more detailed levels.

The construction of the hierarchy is considered the most demanding stage of AHP. In its typical form, the hierarchy consists of four levels: the overall goal, criteria, subcriteria, and decision alternatives, although more complex or simplified structures are also used depending on the decision problem (Saaty and Forman 1992). Because the hierarchy largely determines the reliability of the results, Prusak and Stefanów (2014) proposed several methodological principles for its construction, including completeness, clear terminology, uniqueness of elements, progression from general to specific, independence of elements within each level, an optimal number of compared elements (Miller 1956), homogeneity, and a balanced hierarchy.

Once the hierarchy has been established, the elements within each cluster are evaluated using pairwise comparisons (PC), in which every element is compared with every other element in the same cluster. Consequently, all possible pairwise combinations are assessed, resulting in a deliberately redundant set of judgments. Their purpose is to determine the relative importance of one element with respect to another under the corresponding parent criterion. Although the idea of PC predates AHP and can be traced to Ramon Llull (Colomer 2013), Saaty (1977) formalized this approach by introducing the fundamental 1-9 comparison scale, together with reciprocal values expressing the opposite preference. These judgments form PC matrices, which constitute the basis for calculating priority vectors (also referred to as weights or priorities).

Priority vectors may be derived using several methods; the principal eigenvector method, originally proposed by Saaty, is the classical (although not simple) AHP approach. Therefore, the geometric mean method is often preferred instead because of its computational simplicity and comparable results. Depending on the level of aggregation, the obtained priorities may be interpreted as local, global, or ideal priorities, allowing the final ranking of decision alternatives to be established (Saaty 2008).

An important advantage of AHP is the possibility of assessing the logical consistency of expert judgments. Since pairwise comparison matrices intentionally contain redundant comparisons, the Consistency Index (CI) and Consistency Ratio (CR) can be calculated by comparing the observed inconsistency with the Random Index (RI). According to Saaty, CR values below 0.10 are generally considered acceptable, whereas higher values indicate that some judgments should be reconsidered. A detailed discussion of CI and CR calculations is presented by Prusak (2017).

The final stage consists of synthesizing local priorities into global priorities and obtaining the final ranking of alternatives. In group decision-making, this synthesis may additionally involve aggregating the judgments or priority vectors of individual experts (Forman and Peniwati 1998). Finally, sensitivity analysis should be performed to evaluate the robustness of the results by examining how changes in criteria weights or judgments affect the ranking of alternatives. This enables the identification of critical criteria and assessment of the overall reliability of the decision model (Triantaphyllou and Sánchez 1997).

Methodology of the bibliometric study in R

The bibliometric analysis was conducted on a dataset comprising approximately 50000 scientific journal articles related to the Analytic Hierarchy Process (AHP), published between 1980 and 2025. The starting year was selected deliberately, as 1980 marks the aforementioned publication of Saaty's seminal book (1980), which formally introduced the AHP methodology (although several earlier articles had already presented the theoretical foundations of pairwise comparisons and hierarchical decision-making, e.g., Saaty 1977). Bibliographic data were extracted using [Lens.org](https://lens.org/), an open-access scholarly database and bibliometric platform integrating metadata from multiple scientific sources and indexing services, namely: [CrossRef](#) (Hendricks *et al.* 2020) [PubMed](#) (Canese and Weis 2013), [OpenAlex](#) (Priem *et al.* 2022) and [Microsoft Academic](#) (Sinha *et al.* 2015). The exported metadata included, among others, variables such as Lens ID, Title, Publication Type, Source Title, Field of Study, ISSN identifiers, Publisher, Source Country, Publication Year, PMID, Microsoft Academic ID, Citation Indicators (including citing patents count and citing works count), Open-access Status, and Publication Date.

The initial extended search query:

Scholarly Works (1,770,086) = AHP OR (analytic AND (hierarchy AND process))

returned more than 1,7 million records across all document types and metadata fields. In order to improve the precision and thematic relevance of the dataset, the search was restricted to publications from 1980 onward. The

resulting query was 147829 publications. In the following stage, the *Field of Study* criterion was removed in order to avoid retrieving publications only indirectly associated with AHP methodology. The search expression was therefore narrowed to:

Scholarly Works (91,178) = Title: AHP OR (Abstract: AHP OR (Keyword: AHP OR (Title: (analytic AND (hierarchy AND process)) OR (Abstract: (analytic AND (hierarchy AND process)) OR Keyword: (analytic AND (hierarchy AND process))))))

Finally, to ensure greater methodological consistency and scientific comparability of the analyzed material, the search was additionally restricted exclusively to *journal articles*, excluding conference proceedings, books, dissertations, book chapters, editorials, and other publication types.

The final dataset consisted of 50000 of the most relevant AHP-related records, which also corresponds to the maximum number of records that can be exported from Lens.org within the limitations of the free-access version of the platform. The bibliographic metadata were exported to a CSV file and subsequently analyzed using the *R* programming language and *RStudio* compiler. Instead of employing the widely used *bibliometrix* package, the analysis relied on custom data-processing and visualization procedures implemented with selected *R* libraries. Although *bibliometrix* offers extensive functionalities for bibliometric network analysis (e.g., co-authorship, citation, and keyword networks), such analyses were not the primary objective of the present study. Moreover, the package provides relatively limited flexibility with respect to detailed graphical customization and advanced visual control of figures. Therefore, the analysis was conducted using dedicated libraries, including: *readr* for importing and processing CSV data; *dplyr* for data transformation and aggregation; *ggplot2* for advanced statistical visualization; *scales* for axis scaling and formatting; *ggalluvial* for constructing alluvial diagrams illustrating the evolution of research areas over time; *rnaturalearth* for spatial and geographic data visualization; and *countrycode* for standardizing and converting country identifiers in international publication analyses.

Thematic developments (*Fields of Study* and *Keywords* metadata) were examined using alluvial diagrams. This visualization technique is particularly suitable for longitudinal bibliometric analyses, because it allows the tracking of thematic flows between successive time periods. The width of individual streams reflects the relative importance of a given research area, while changes in stream size over time indicate the emergence, growth, decline, or stabilization of particular topics. The alluvial diagrams were generated using the *ggalluvial* package (Brunson 2020).

Results and Discussion

The bibliometric data concerning the number of scholarly works (journal articles) (**fig. 1**) clearly demonstrate the dynamic and continuously accelerating development of AHP-related scientific research since its introduction in 1980.

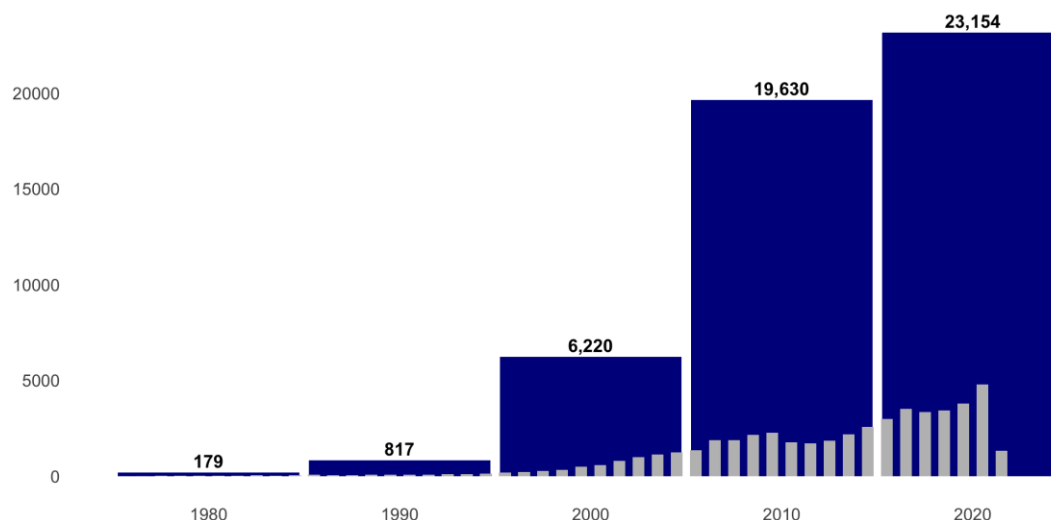


Fig. 1. Number of scholarly works (journal articles) per years and per decades

During the 1980s, publication activity remained relatively limited, with only 179 articles indexed in total. Nevertheless, even within this initial period a gradual increase in scientific interest can already be observed, as annual publication counts grew from only 2 papers in 1980 to 49 in 1987. A significantly stronger growth phase

emerged during the 1990s, when the total number of publications increased to 817. This decade can be interpreted as the period of international dissemination and methodological consolidation of AHP, accompanied by its growing adoption across different scientific and applied disciplines. By the end of the decade, annual publication output exceeded 140 papers. The 2000s marked the transition of AHP into a broadly recognized and intensively applied MCDM. During this decade, the total number of indexed publications increased to 6220, with annual publication counts rising systematically from 182 papers in 2000 to more than 1200 by 2009. This period reflects the rapid expansion of AHP applications. An even stronger acceleration occurred during the 2010s, which generated 19630 publications - more than three times the output of the previous decade. This period represents the mature phase of AHP research characterized by extensive interdisciplinary diffusion, with annual publication output exceeding 2500 papers by the end of the decade. The 2020s already constitute the most productive period in the history of AHP research, despite the fact that the decade is still incomplete. Between 2020 and 2026, the database recorded 23154 publications, already surpassing the entire output of the 2010s. Annual publication counts fluctuated between approximately 3000 and nearly 4800 papers, indicating the sustained popularity of AHP. This trend is particularly noteworthy given the emergence of numerous new intelligent decision-support approaches and advanced computational methods in recent decades. The visibly lower number of publications recorded for 2026 should not be interpreted as a decline in scientific interest, since the bibliometric data for the current year remain incomplete and continue to be updated dynamically within indexing databases. As regards publication sources (*Source Titles*), the distribution reveals a diversified dissemination pattern of AHP-related papers (**fig. 2**).

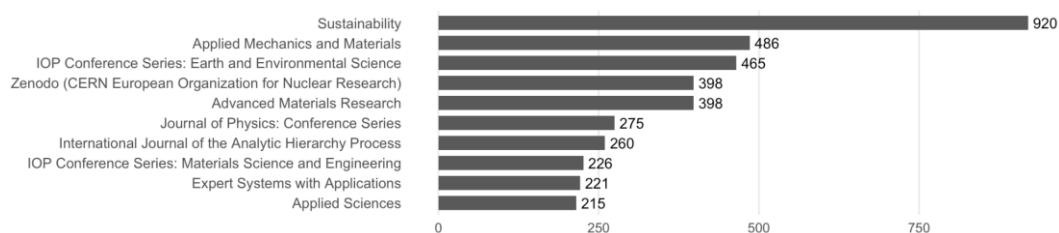


Fig. 2. Top 10 Source Titles in AHP research

The largest number of publications was recorded in *Sustainability* (920 papers), followed by *Applied Mechanics and Materials* (486) and *IOP Conference Series: Earth and Environmental Science* (465). The prominence of journals such as *Sustainability*, *Applied Mechanics and Materials* or *Expert Systems with Applications* reflects the application of AHP in sustainability assessment, decision-support systems, management, engineering, and environmental studies. Particularly noteworthy is the presence of the *International Journal of the Analytic Hierarchy Process* among the most productive publication outlets. As the only journal dedicated specifically to AHP and related methodologies, it serves as a specialized platform for methodological developments, theoretical discussions, and practical applications of the method. Overall, the diversity of publication sources indicates that AHP has evolved into a highly interdisciplinary methodology applied across a broad spectrum of scientific domains. It should be noted, however, that the classification of *Source Titles* follows the metadata provided by Lens.org. Consequently, some highly productive sources include conference-oriented series, repository-based records and hybrid publication outlets, such as *IOP Conference Series: Earth and Environmental Science*, which are indexed by the database as journal articles. Therefore, the results should be interpreted as reflecting the publication ecosystem represented within the Lens database rather than a strict distinction between conventional peer-reviewed journals and conference-related serial publications.

To analyse the thematic evolution of AHP research, the alluvial diagrams were employed for both the *Fields of Study* and *Keywords* metadata, reflecting the representation of the evolving thematic landscape of AHP research. **Fig. 3** presents the thematic evolution of AHP research based on *Fields of Study* metadata. The visualization reveals the highly interdisciplinary nature of AHP-related research, as individual publications are typically associated with multiple scientific domains. After filtering incomplete records, 47462 publications generated 553029 field assignments corresponding to 21146 unique research fields, indicating a remarkable diversity of application areas.

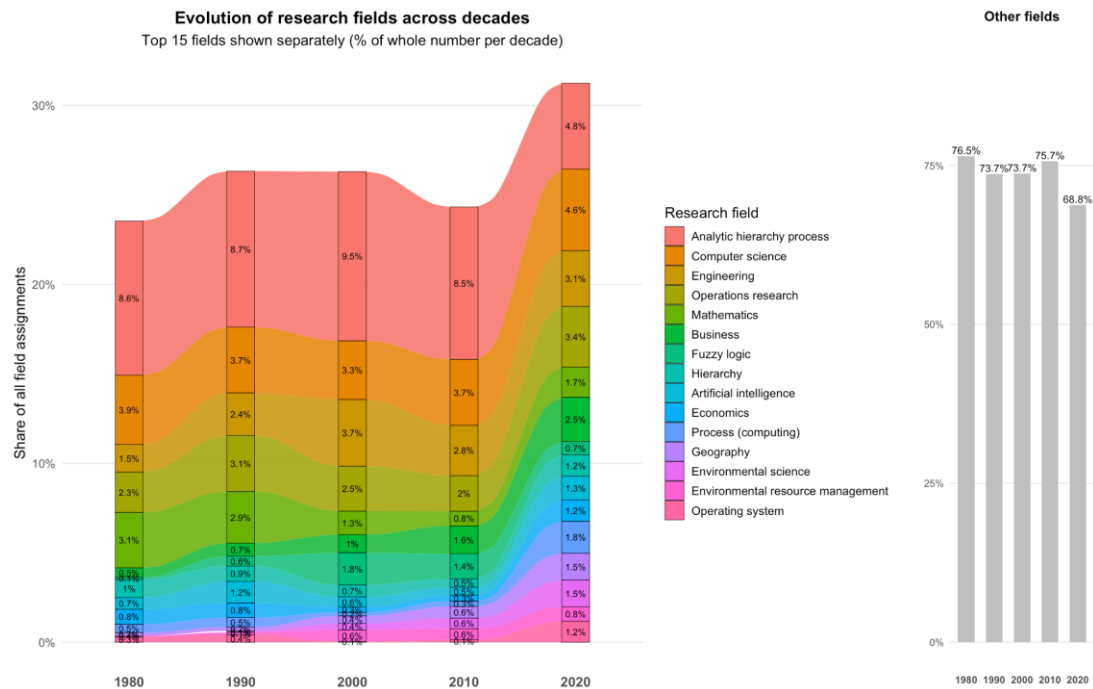


Figure 3. Evolution of the *Fields of Study* in AHP research

To improve readability, the left panel of the figure displays the 15 most frequently occurring research fields, while the right panel aggregates all remaining fields into the category *Other*. This dual representation improves readability by focusing on the dominant thematic areas while simultaneously preserving information about the long tail of less frequent disciplines. The results show that relative importance of the leading research fields has increased over time. In the 1980s, the 15 most frequent fields accounted for approximately 23,5% of all field assignments, whereas in the 2020s their combined share exceeded 30%. Consequently, the share of the aggregated *Other* category decreased from approximately 76,5% to 68,8%. This trend suggests a gradual consolidation of AHP research around a set of dominant disciplines and application domains, although the method continues to exhibit a high degree of interdisciplinarity, as evidenced by the large number of remaining fields grouped within the *Other* category.

Several fields exhibit a clear long-term growth trend. The share of *Business* increased from 0,54% in the 1980s to 2,48% in the 2020s, while *Computer Science* grew from 3,86% to 4,56%. Similarly, *Operations Research* remains consistently important and rises from 2,26% to 3,39% over the analyzed period. These patterns confirm the growing importance of AHP in managerial, computational, and decision-support applications. Environmental disciplines also show expansion: *Environmental Science*, *Environmental Resource Management*, and *Geography* increase their relative shares over time, reflecting the widespread adoption of AHP in sustainability assessment, environmental planning, natural resource management, and spatial decision-making. In particular, *Geography* increases from 0.18% in the 1980s to 1.50% in the 2020s. By contrast, several fields that played a prominent role in the early development of AHP have experienced a relative decline. For example, *Mathematics* decreased from 3,09% in the 1980s to 1,69% in the 2020s, while *Hierarchy* declined from 1,01% to 0,48% in the 2010s before partially recovering. This pattern suggests that research has gradually shifted from methodological and theoretical considerations toward practical applications. Another noteworthy trend is the emergence of *AI*. Although its share remained below 1% for several decades, it reached 1,32% in the 2020s, indicating increasing integration between AHP and contemporary intelligent decision-support systems. Similar growth can be observed for fields related to computing and information systems, including *Process (Computing)* and *Operating System*.

Fig. 4 presents the thematic evolution of author keywords using an alluvial diagram analogous to that employed for the *Fields of Study* analysis. However, unlike the *Fields of Study* metadata, which are assigned automatically by the Lens.org platform, keywords are provided directly by authors and therefore more accurately reflect the specific topics, methods, and application domains addressed in individual studies.

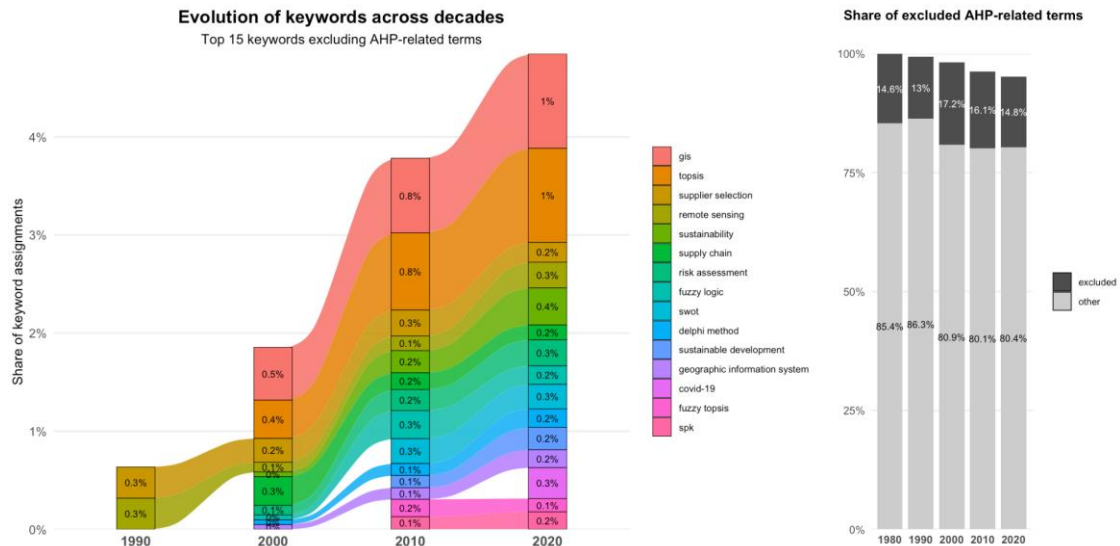


Figure 4. Evolution of the *Keywords* in AHP research

To avoid the dominance of generic methodological terms, a number of highly frequent and non-informative keywords were excluded from the analysis, including various forms of *Analytic Hierarchy Process (AHP)*, *MCDM*, *MCDA*, *decision making*, *decision support system*, *criteria*, *fuzzy*, and related variants. The objective was to reveal the substantive application areas and methodological combinations associated with AHP rather than repeatedly identifying the method itself.

In contrast to the previous results, the concentration of the most frequent keywords is considerably lower. Even after excluding generic methodological expressions, the fifteen most common keywords account for less than 20% of all keyword occurrences, while the category *Other* consistently represents approximately 80% of the total keyword volume. These excluded terms are represented separately by the darker sections within the *Other* category, thereby preserving their contribution to the overall keyword distribution.

Among the most prominent keywords, several thematic clusters can be identified. One group is related to spatial and environmental applications, including *GIS*, *Geographic Information System*, and *Remote Sensing*, whose importance increases steadily over time. Another cluster comprises sustainability-related topics, represented by *Sustainability* and *Sustainable Development*, both of which exhibit clear growth in the 2010s and 2020s. A third cluster includes methodological integrations, particularly *TOPSIS*, *Fuzzy TOPSIS*, *Fuzzy Logic*, and the *Delphi Method*, indicating the increasing tendency to combine AHP with other decision-support and multi-criteria evaluation techniques.

The results also highlight the growing importance of risk-oriented applications, reflected by the increasing occurrence of *Risk Assessment*, as well as management-related topics such as *Supplier Selection*, *Supply Chain*, and *SWOT*. Furthermore, the appearance of *COVID-19* among the leading keywords in the 2020s demonstrates the responsiveness of the AHP research community to contemporary global challenges.

Conclusions

This study presented a large-scale bibliometric analysis of the scientific literature related to the Analytic Hierarchy Process (AHP) published between 1980 and 2026. Based on a dataset of 50000 journal articles extracted from the *Lens.org* database, the study examined the temporal evolution, geographical distribution, publication sources, research fields, and thematic structure of AHP-related research. The results demonstrate the remarkable and sustained growth of AHP over the last decades. From only 179 publications in the 1980s, the number increased to 23,154 publications in the still incomplete decade of the 2020s. The continuous increase in publication output confirms that AHP has evolved from a relatively specialized decision-support technique into one of the most influential and widely applied methodologies within the field of multi-criteria decision-making. Particularly noteworthy is the fact that, despite the rapid development of artificial intelligence, machine learning, data analytics, and advanced optimization techniques, AHP continues to attract growing scientific interest and shows no signs of declining relevance.

The bibliometric evidence indicates that AHP has entered a mature stage of development characterized by extensive interdisciplinary diffusion and methodological integration. The method is increasingly combined with fuzzy sets, GIS technologies, sustainability assessment frameworks, risk analysis methods, engineering optimization techniques, and artificial intelligence tools. This trend reflects the flexibility of AHP and its ability to adapt to emerging scientific challenges and application domains. Particularly important insights were obtained from the thematic analyses based on both *Fields of Study* and author-defined keywords. The *Fields of Study* analysis revealed an exceptionally high level of interdisciplinarity, with 47462 publications generating 553029 field assignments distributed across 21146 unique research fields. The alluvial analysis demonstrated both the growing concentration of research around several dominant disciplines and the continuing diversification of application areas. While the leading 15 research fields increased their combined share over time, a substantial proportion of publications remained distributed across thousands of smaller thematic categories.

The keyword analysis largely confirmed the patterns identified through the *Fields of Study* metadata while providing a more detailed perspective on specific application domains and methodological combinations. The growing prominence of keywords related to sustainability, GIS, remote sensing, risk assessment, supplier selection, TOPSIS, fuzzy logic, and the Delphi method illustrates the expanding range of AHP applications and integrations. At the same time, the relatively small cumulative share of the 15 most frequent keywords demonstrates that AHP research remains highly fragmented and diversified. This finding reflects the nature of author-defined keywords, which capture a much broader variety of topics, case studies, and emerging themes than standardized disciplinary classifications. Overall, the results confirm that AHP remains one of the most dynamic, versatile, and influential methodologies in contemporary decision science. More than four decades after its formal introduction by Saaty, the method continues to evolve, expand into new application domains, and maintain its relevance within an increasingly complex and data-intensive scientific environment.

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