Цифровая экономика

THE IMPACT OF INFORMATION TECHNOLOGY ON STADIUM ATTENDANCE STUDIES: A COMPREHENSIVE BIBLIOMETRIC REVIEW

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Abstract

This paper provides a systematic and quantitative review of stadium attendance literature from 1980 to 2024, with a focus on the transformative role of information technology and data analytics within the sports economics field. We identify leading authors, seminal articles, and major journals, utilizing trend analysis, collaborator network relationships, keyword co-occurrence analysis, and methodological examination to scrutinize past research. The analysis shows that key terms such as "demand," "uncertainty of outcomes," and "competitive balance" dominate the field, with "public health" and "big data" emerging as significant topics. Notably, we highlight the introduction and growing influence of machine learning techniques, first emerging in the early 2010s and increasingly predominant in recent years. This analysis not only tracks the evolution of data analytics technologies but also illustrates their profound impact on the field, particularly in enhancing predictive models and decision-making processes. The study concludes with strategic recommendations for integrating these technological advances to further elevate research and practice in sports management. Our findings underscore the critical role of innovative data analytics in shaping the future of sports economics, aligning with the evolving needs of the information society where such technological insights are becoming indispensable.

Keywords

information technology; stadium attendance; bibliometric analysis; data analytics; sports management

Introduction

Stadium attendance is a pivotal aspect of sports economics, shaped by broad economic, social, and technological trends that impact the sports industry and its global audience [1]. Variations in attendance not only influence the financial health of sports organizations but also affect local economies and community engagement [2]. Over the years, research has broadened to include factors such as team performance, economic conditions, fan loyalty, and more recently, public health issues.

As the volume of literature has expanded, reflecting a rise in research output, there has been an increasing focus on how advancements in big data science impact this field [3]. However, there remains a notable gap in the comprehensive analysis of how information technology and data analytics specifically influence stadium attendance research. This gap is most apparent in the sparse exploration of how big data and advanced analytical tools have enhanced the understanding and prediction of attendance trends.

This paper aims to bridge this gap by conducting an in-depth quantitative analysis of existing literature, with a particular focus on how the integration of advanced data analytics has revolutionized research methodologies. We explore how the adoption of big data, machine learning, and other data-driven

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technologies has led to more nuanced and predictive insights into fan behavior. This assessment not only fills a critical void in current studies but also provides practical guidance on utilizing these technologies to improve research outcomes in sports economics.

Our systematic review identifies key trends, methodologies, and thematic developments in stadium attendance research from 1980 to 2024. By synthesizing existing knowledge, we highlight important methodological trends and their implications for both theory and practice. Furthermore, we outline future research directions, emphasizing the importance of embracing technological advancements in data collection and analysis. This approach not only addresses the evolving needs and complexities of sports management but also aligns with the broader trends of the information society, where digital transformation and data-centric strategies increasingly define the contours of modern research and industry practices. These developments underscore the critical intersection between sports management and the information society, illustrating how technological fluency is essential to navigating the complexities of contemporary economic landscapes.

1 Materials and Method

1.1 Data Sources

We conducted a comprehensive bibliometric review on the impact of information technology and data analytics on stadium attendance studies by gathering relevant literature from academic databases. The primary databases considered for this study were Web of Science and Scopus. These databases were chosen for their extensive coverage of peer-reviewed journals, conference proceedings, and other academic publications [4]. After a thorough evaluation of both databases, we identified Scopus as the most comprehensive source for sports-related literature. The overlap between Web of Science and Scopus was significant, with Scopus covering the majority of relevant publications. This coverage includes not only a broad array of journals and conference proceedings relevant to both sports management and technology applications but also ensures a significant representation of interdisciplinary studies that intersect with the field of sports economics and information systems. Therefore, we finalized Scopus as our sole data source for its consistency and broad coverage of the literature in this field, which is instrumental for an exhaustive and accurate representation of the current landscape and trends in the research area. By relying on Scopus, we ensure that our review encompasses the most comprehensive, relevant, and up-to-date scholarly articles, thereby providing a robust foundation for analyzing the influence of information technology and data analytics on stadium attendance.

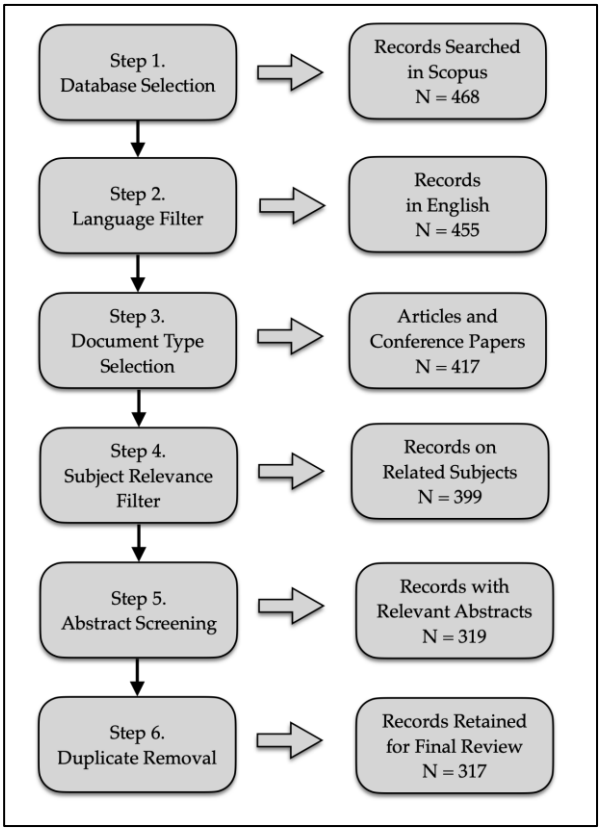

Figure 1. Flowchart of Document Screening Process for a Bibliometric Analysis in Scopus

The literature search was conducted using keywords and phrases relevant to stadium attendance research, building on previous studies [5]. To emphasize the data analysis aspect of the paper, additional keywords such as "model," "analyze," "measure," and "predict" were included. Boolean operators (AND, OR) were employed to expand the search scope for a comprehensive review. Wildcards (e.g., stadi* to include "stadium," "stadiums," and "stadia") were used to capture all variations of key terms. This approach ensured a thorough review of studies addressing sports attendance and related research variables.

On July 9, 2024, we conducted a search in the multidisciplinary database Scopus to identify relevant articles on stadium attendance analysis. The filtering process, outlined in Figure 1, involved several steps to ensure the selection of pertinent studies. We limited the search to English-language articles and conference papers, excluded irrelevant subjects, reviewed all abstracts, and removed duplicate documents. This process resulted in a final database of 317 documents.

For each selected publication, we collected the following bibliometric data: 1) Title, authors, full names of authors, and year of publication. 2) Journal name or conference title. 3) Keywords and abstract. 4) Citation count and impact factor. 5)Authors' affiliations and countries of origin. This information was organized into a database for analysis.

1.2 Research tools and procedures

The analysis was conducted using Python (3.11), R (4.4.1), and Microsoft Excel. Initially, we downloaded the .csv file from the Scopus database and performed preliminary analysis in Excel, removing irrelevant data. We then used Python to develop a text processing program to extract document information from the database. For trend analysis, we employed the Seaborn package, and for co-authorship analysis and visualization, we utilized the NetworkX package. Additionally, we built a dictionary to categorize and extract relevant methodological keywords from the abstracts. Final visualizations were created using the Matplotlib package.

Keyword Co-Occurrence Network analysis was performed using the Biblioshiny app in RStudio by executing the biblioshiny() command. Biblioshiny provides a web interface for the Bibliometrix package in RStudio, following a logical bibliometric workflow. This tool delivers clear and concise visualizations, enabling easy identification of relevant analysis trends.

2 Results and Discussion

This section presents the findings from the bibliometric analysis of research on stadium attendance. The analysis encompasses various aspects, including publication trends, author collaborations, key themes, and methodological approaches. By examining these elements, we aim to uncover how IT and data analytics have shaped the field, highlighting significant contributions, emerging trends, and areas for future research. The results are discussed in detail to provide a comprehensive understanding of the current state and evolution of stadium attendance research, emphasizing the transformative impact of technological advancements.

2.1 Trend Analysis

Trend analysis offers a comprehensive examination of the patterns in stadium attendance research spanning the last several decades.

Figure 2 illustrates the yearly trends in the publication of articles on stadium attendance from 1980 to 2024. The graph shows a marked increase in research output over the years. Between 1980 and 2007, the publication volume remained consistently low, rarely exceeding six articles per year. However, from 2008 onwards, there was a noticeable rise in the number of publications, indicating a growing interest in this area of research. The increase became more pronounced from 2018, with publications exceeding 20 articles annually, except in 2019 which saw a slight drop to 18 articles. The peak occurred in 2022 with 33 publications, underscoring a sustained interest and active research in the field. This trend underscores a significant escalation in scholarly engagement and research output throughout the examined period.

2.2 Key Authors and Co-authorship Analysis

This section explores the collaborative networks among leading authors in the field of stadium attendance research. By mapping out the co-authorship links, we identify central figures who significantly contribute to the development and dissemination of knowledge in this area. The analysis highlights the

interconnections between researchers and provides insights into the structure of academic collaboration that drives advancements in understanding stadium attendance dynamics.

Table 1 presents a detailed summary of the publication and citation metrics for leading authors in the field of stadium attendance research. For each author listed, the table provides the total number of papers published, the cumulative citations received, and the average citations per paper (ACP). The data highlights Schreyer, Dominik as having published nine papers with a total of 226 citations and an ACP of 25.1, indicating a significant impact in the field. Other notable authors include Funk, Daniel C., with five papers but the highest citation count at 556 and an ACP of 111.2, demonstrating substantial influence per publication.

Figure 2 displays the co-authorship network among researchers, refined by a collaboration threshold of more than three joint works. This visualization includes nodes that represent individual authors, linked by lines that signify co-authored papers. Lines are color-coded to denote previous collaborations between authors, with line thickness reflecting the volume of joint publications. The network comprises seven clusters, which include three groups of three authors each and four dyads. Notably, Jakobsen, Tor Georg and Storm, Rasmus K. emerge as the most frequent collaborators with six joint publications, highlighting a significant research partnership within the network.

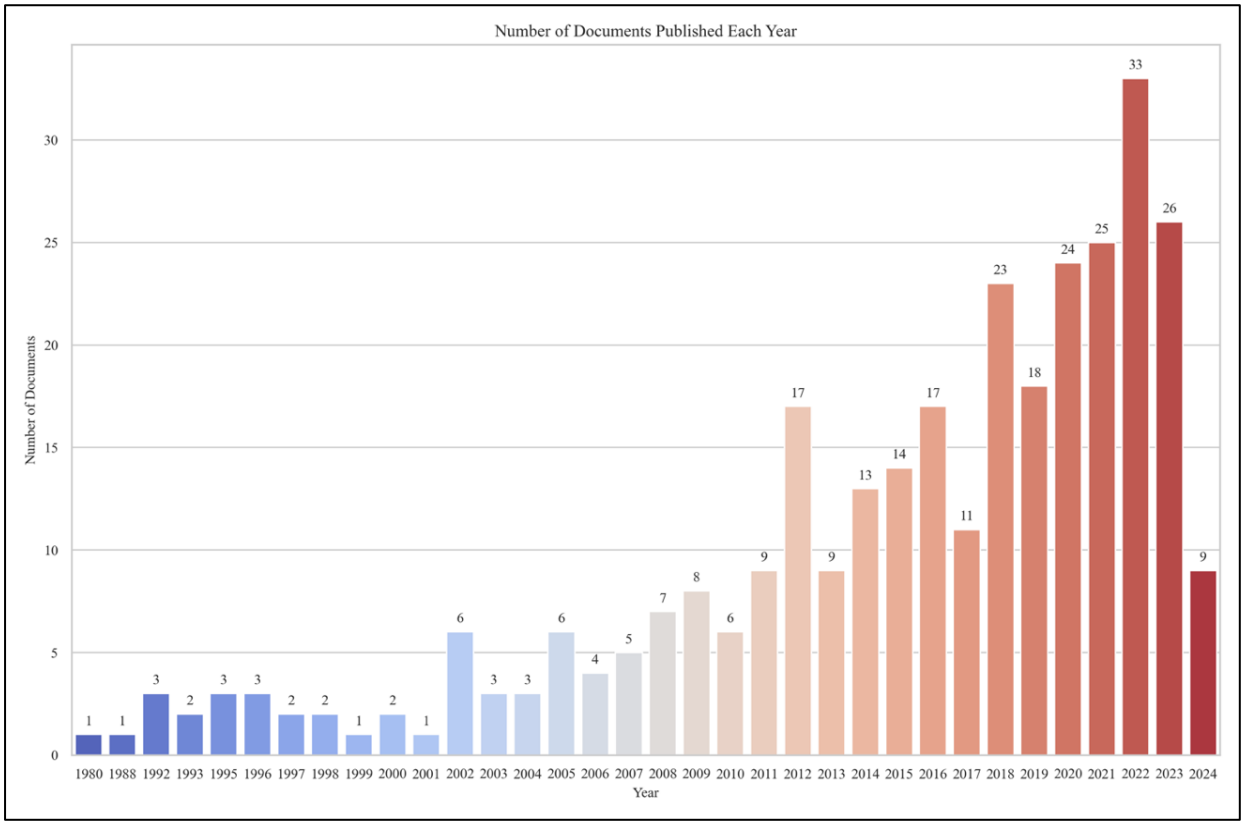

Figure 2. Publication trends

Table 1. Leading Authors in Stadium Attendance Research

Author's Name	Paper Count	Total Citations	ACP
Schreyer, Dominik	9	226	25.1
Jakobsen, Tor Georg	7	52	7.4
Simmons, Robert	7	537	76.7
Buraimo, Babatunde	7	235	33.6
Storm, Rasmus K.	6	35	5.8
Humphreys, Brad R.	6	259	43.2
Thomas, Dennis	5	377	75.4

Watanabe, Nicholas M.	5	122	24.4
Soebbing, Brian P.	5	104	20.8
Lera-López, Fernando	5	87	17.4
Funk, Daniel C	5	556	111.2
DeSchriver, Timothy D.	5	183	36.6

Note: 1) The citation data is from Scopus database. **2)** ACP = the average citations per paper.

2.3 Key Publications and Thematic Analysis

This section examines the cornerstone literature and thematic trends that shape research on stadium attendance. It features a list of the most frequently cited papers and a Keyword Co-Occurrence Network, which together highlight seminal works and key contributions that have influenced further research. These elements also map the interconnections between central themes across the literature. Collectively, they provide a comprehensive overview of the intellectual landscape and thematic focus within this field.

Table 2 showcases the most frequently cited papers in our database, highlighting influential research in the field of stadium attendance. The table is organized by title, authors, publication year, and the number of citations each paper has received. Notably, "Outcome uncertainty and attendance demand in sport: The case of English soccer" by Forrest D. and Simmons R., published in 2002, leads with 249 citations. It is followed closely by "Small-scale event sport tourism: Fans as tourists" by Gibson H.J. et al., which has accrued 231 citations since 2003. Other significant contributions include studies on various factors influencing sports spectator behavior, focusing on motives, emotions, and economic aspects affecting attendance at football matches and other sporting events. Key topics include consumer involvement, brand equity in sports teams, outcome uncertainty, and comparisons between traditional sports and eSports spectator motives.

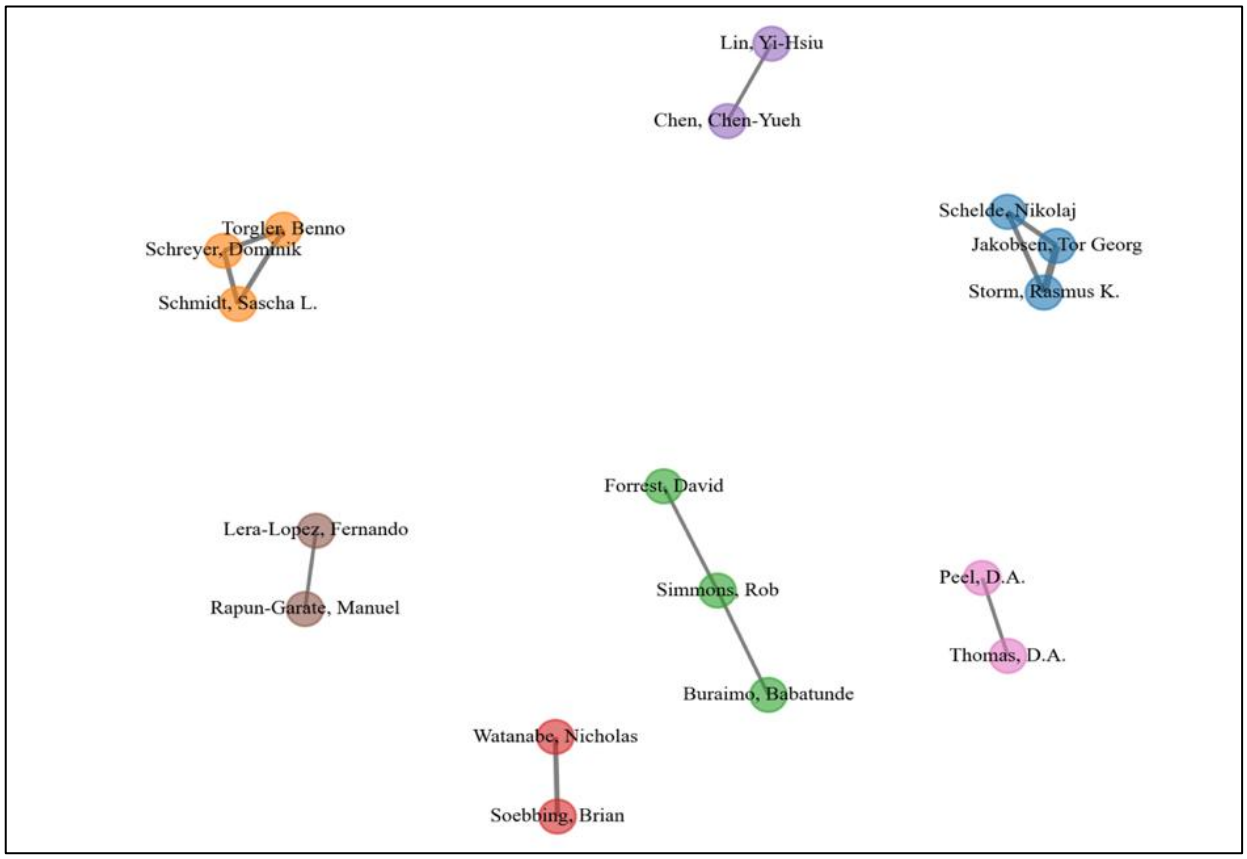

Figure 3. Collaboration network of authors

Table 1. Most frequently cited papers in our database

Title	Authors	Year	Cited by

Outcome uncertainty and attendance demand in sport: The case of English soccer [6]	Forrest D.; Simmons R.	2002	249
Small-scale event sport tourism: Fans as tourists [7]	Gibson H.J.; Willming C.; Holdnak A.	2003	231
The Determinants of Football Match Attendance Revisited: Empirical Evidence from the Spanish Football League [8]	García J.; Rodríguez P.	2002	227
Exploring origins of involvement: Understanding the relationship between consumer motives and involvement with professional sport teams [9]	Funk D.C.; Ridinger L.L.; Moorman A.M.	2004	201
The role of emotion in explaining consumer satisfaction and future behavioural intention [10]	Martin D.; O'Neill M.; Hubbard S.; Palmer A.	2008	197
Reference-dependent preferences, loss aversion, and live game attendance [11]	Coates D.; Humphreys B.R.; Zhou L.	2014	166
Customer-based brand equity in the team sport industry: Operationalization and impact on the economic success of sport teams [12]	Bauer H.H.; Sauer N.E.; Schmitt P.	2005	154
The demand for football: Some evidence on outcome uncertainty [13]	Peel D.A.; Thomas D.A.	1992	151
eSport vs. Sport: A comparison of spectator motives [14]	Pizzo A.D.; Baker B.J.; Na S.; Lee M.A.; Kim D.; Funk D.C.	2018	143
Do sports fans really value uncertainty of outcome? Evidence from the English premier league[15]	Babatunde B.; Rob S.	2008	141

Note: The citation data is from Scopus database.

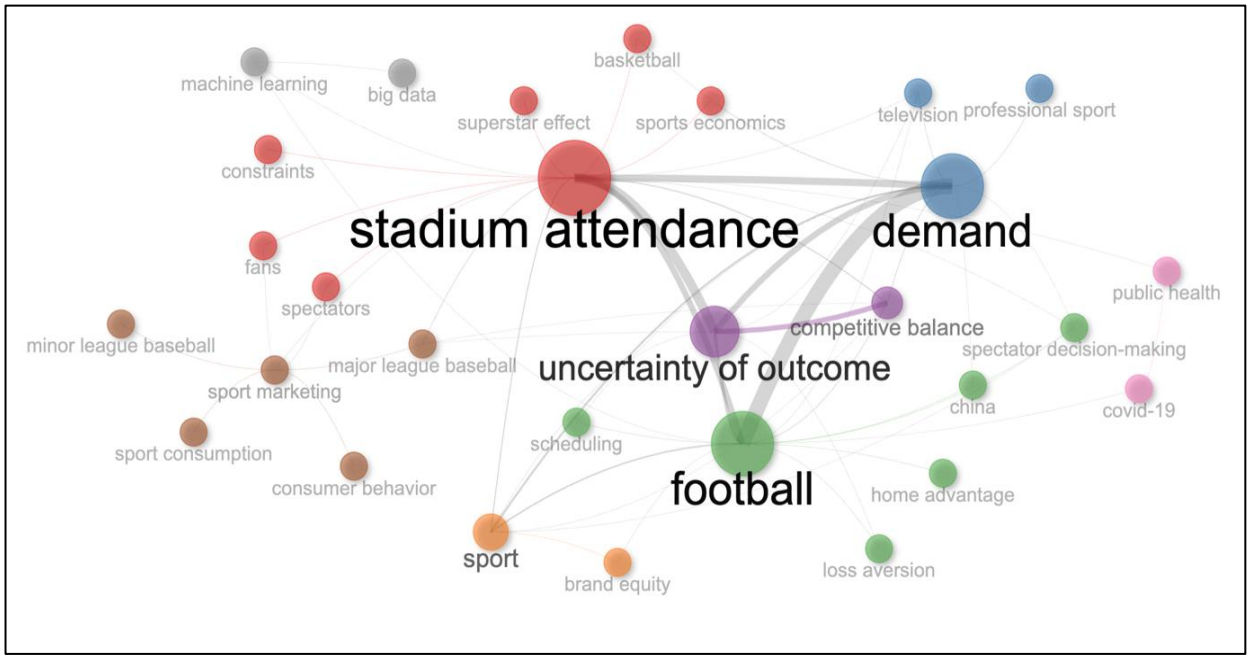

Figure 4. Keyword Co-Occurrence Network

Figure 4 displays a Keyword Co-Occurrence Network that illustrates the relationships and thematic focuses in stadium attendance research. This network utilizes author-provided keywords, requires a minimum of two connections for inclusion, and contains 30 nodes analyzed via the InfoMap clustering algorithm. In the diagram, keywords appear as nodes, with their size indicating the term's frequency in the research literature. Lines between nodes represent term co-occurrence within documents, highlighting thematic connections. "Stadium attendance" emerges as a central theme, signifying the primary focus of

the research. Other prominent terms include "demand," "uncertainty of outcome," and "football," each marking critical areas of study. The network also underscores discussions about factors affecting stadium attendance and how outcome uncertainty impacts attendance figures. Football is notably the most studied sport, reflecting its significance in the field. The network includes other sports like basketball and baseball, specifically noted as "Major League Baseball," and themes such as "sports marketing," "sports consumption," and "sports economics." Topics like the "superstar effect" and "home advantage" are also prevalent. Additionally, emerging areas such as public health implications on stadium attendance, highlighted by references to "COVID-19," and advances in "machine learning" indicate new research directions. This visualization offers a comprehensive overview of the interconnected topics within sports economics and management, identifying both traditional and emerging areas of interest.

2.4 Key Sources and Methodological Analysis

This section provides an overview of the most influential journals and the evolving methodologies in stadium attendance research. By identifying key sources, such as the most productive and highly cited journals, we establish the foundational literature that has shaped the field. Additionally, we analyze the methodological trends over time, highlighting the transition from traditional statistical methods to advanced data analytics and machine learning techniques.

Table 3 lists the most productive journals in the field of stadium attendance research, indexed by the number of publications, total citations, and h-index. The Journal of Sports Economics leads with 31 publications, 1271 citations, and an h-index of 56. Applied Economics and the Journal of Sport Management both have 16 publications, but differ in citations and h-index, with Applied Economics having 351 citations and an h-index of 113, while the Journal of Sport Management has 577 citations and an h-index of 83. Applied Economics Letters follows closely with 15 publications, 464 citations, and an h-index of 63. Other notable journals include the International Journal of Sports Marketing and Sponsorship, European Sport Management Quarterly, International Journal of Sport Finance, and International Journal of Sport Management and Marketing, each contributing significantly to the research area.

Figure 5 showcases the evolution of analytical methods used in stadium attendance research, reflecting the dynamic interplay between methodological innovation and the increasing complexity of questions in sports economics.

Regression analysis, consistently used since the 1980s, illustrates its enduring significance and foundational role within the field. Its persistent application highlights the continuous reliance on traditional statistical methods to interpret data related to stadium attendance. Descriptive statistics have shown a steady usage from the early 2000s, which emphasizes their crucial role in providing basic, yet essential, data insights that underpin further analysis. Qualitative analysis, which began to gain traction in the early 2000s, remains a pertinent approach. This method reflects a shift towards understanding the deeper, narrative-driven aspects of spectator behavior and stadium attendance. Structural equation modeling, introduced in the same period, has been employed moderately across the years, demonstrating its effectiveness in examining complex relationships between observed and latent variables in stadium attendance studies. Since 2010, multilevel modeling has seen a notable increase in application, signifying a broader acceptance of its utility for analyzing data that involve hierarchical structures, such as data collected from different levels of sports leagues or varied spectator demographics. The recent surge in the use of machine learning techniques indicates a significant paradigm shift toward employing advanced, algorithm-driven methods that offer robust predictive capabilities and can handle large datasets typical in modern research environments.

Table 3. Most productive journals in the relevant research area indexed.

Source title	Number of Publications	Total Citations	*h*-index
Journal of Sports Economics	31	1271	56
Applied Economics	16	351	113
Journal of Sport Management	16	577	83
Applied Economics Letters	15	464	63
International Journal of Sports Marketing and Sponsorship	12	140	33
European Sport Management Quarterly	12	162	49

International Journal of Sport Finance	11	199	29
International Journal of Sport Management and Marketing	10	89	30

Note: 1) The citation data is from Scopus database. **2)** The *h-index* of the journals used in this study was retrieved from Scimago Journal & Country Rank (www.scimagojr.com) on July 11, 2024.

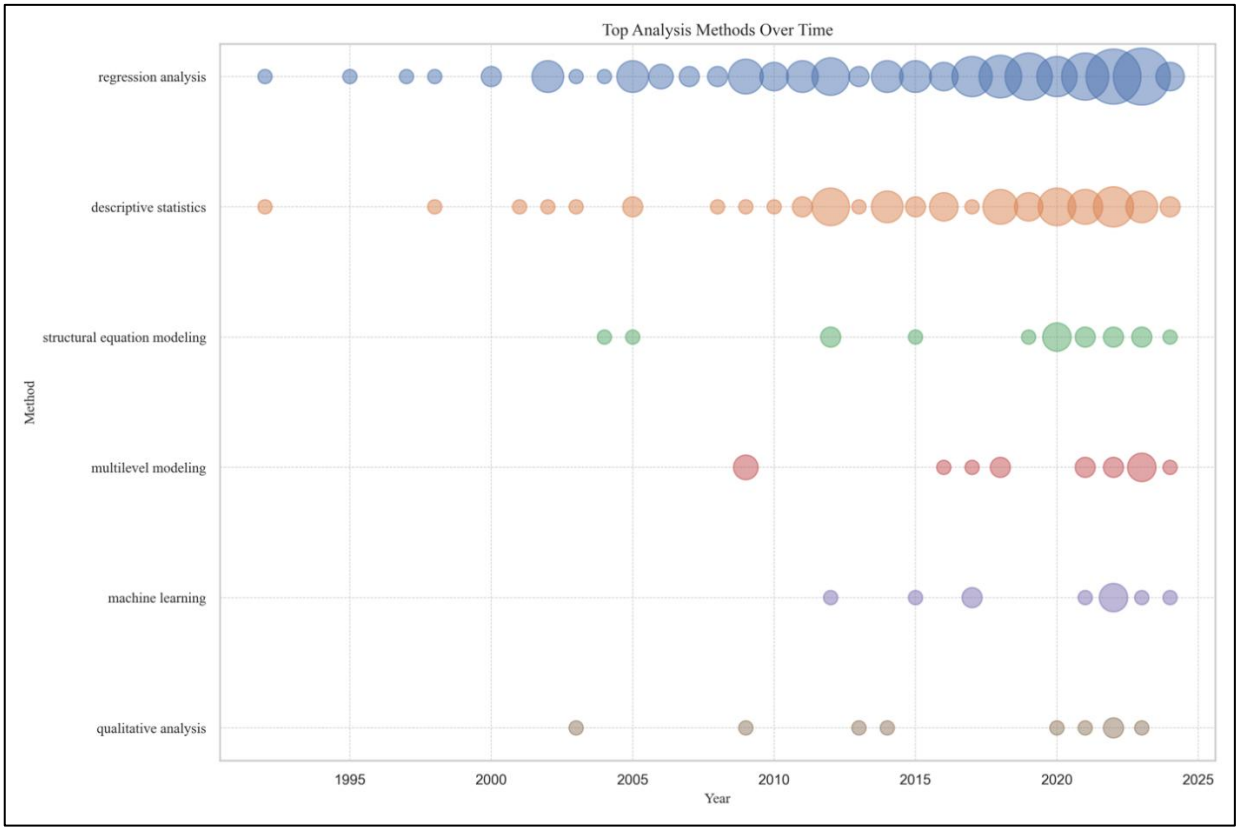

Figure 5. Evolution of research methodologies in stadium attendance research over time

This chart not only illustrates the diversification of methodologies over time but also emphasizes how these methodological advances are closely aligned with technological progress in the broader information society. Such evolution in analytical tools demonstrates the field's adaptation to meet the demands of a digital era, where data-driven insights are crucial for optimizing stadium attendance and enhancing fan engagement.

3 Conclusions

In our comprehensive examination of stadium attendance research, we have observed several significant trends and methodological evolutions spanning from 1980 to 2024. Our analysis began by identifying the increase in published documents related to stadium attendance, which revealed a marked rise particularly from the year 2008 onward. The peak of publication activity in 2022 underscored a sustained interest and an expanding body of research in this area. Through the deployment of a Keyword Co-Occurrence Network, we established the central themes within the corpus of stadium attendance literature. Key topics such as demand, the uncertainty of outcomes, and specific sports like football were prominently featured, reflecting their critical roles in shaping research inquiries and findings. Furthermore, emerging themes like the impact of public health issues, exemplified by discussions around COVID-19, and technological advances such as machine learning have begun shaping the landscape of research, indicating new directions for future studies. It not only illustrates the evolution within sports economics but also emphasizes the interplay between sports management and the broader information society. This transition is driven by the ever-increasing complexity of datasets and the nuanced questions that contemporary sports economics faces, reflecting the growing dependence on advanced data analytics in this field. As sports organizations increasingly rely on data-driven strategies to optimize performance and fan engagement, the integration of cutting-edge information technology has become indispensable.

The profound impact of information technology in sports management is evident in how data insights are leveraged to enhance decision-making processes, from ticket sales and fan engagement to broader strategic planning. This alignment with the information society is crucial, as it highlights the role of digital transformation in enhancing the efficacy and reach of sports management practices. By integrating sophisticated data analysis techniques, sports economics not only aligns with the technological advancements characteristic of the information society but also sets new standards for how sports businesses operate and innovate in an increasingly digital world.

Our study, while comprehensive, is subject to certain limitations primarily related to the scope of data sources utilized. The reliance on a specific database for gathering articles may have restricted the breadth of perspectives and methodologies analyzed. Future research could benefit from a broader array of data sources, encompassing more diverse academic repositories and industry reports to provide a more holistic view of stadium attendance dynamics. Furthermore, we acknowledge the rapid evolution of technology and its impact on sports economics. As such, we suggest future research to incorporate the latest technological advancements in data analysis and collection. This could include the use of real-time data tracking and artificial intelligence to deepen the understanding of fan behavior and preferences. This broader approach will allow for a more comprehensive understanding of the field and its various nuances. Furthermore, as technology continues to evolve, it is crucial for future studies to incorporate the latest advancements in data analysis and collection techniques. The use of real-time data tracking, artificial intelligence, and machine learning should be intensified to explore deeper insights into fan behavior and preferences. These technologies not only offer the potential to enhance the predictive accuracy of research findings but also improve the practical applicability of strategies within sports organizations. By expanding the technological and methodological framework, future research can continue to push the boundaries of knowledge in sports economics, ensuring that the field remains adaptive and responsive to the changing dynamics of the information society.

Notes

1. The precise search query is: (("stadi* attend*" OR "game attend*" OR "match* attend*" OR "sport* attend*" OR "attend* game" OR "attendan* demand" OR "spectator demand" OR "spectator attendance" OR "game visit*" OR "stadi* visit*" OR "visit* match")
AND ("measure*" OR "model*" OR "facto*" OR "determinant*" OR "analy*" OR "predict*" OR "forecas*"))
2. The specific classification codes utilized in our methodological analysis are outlined as follows:

- Regression Analysis: Includes methods such as regression, tobit, demand function, logistic regression, stochastic frontier analysis, explanatory variables analysis, log-linear models, fixed effect models, panel data analysis, statistical significance testing, effect size determination, ordered probit analysis, endogeneity consideration, robust standard errors, nonlinear relationships analysis, generalized linear mixed models (GLMM), instrumental variables (IV), ordinary least squares (OLS), and spatial regression.
- Structural Equation Modeling: Encompasses structural equation modeling (SEM), path analysis, theories of planned behavior, mediation, and moderation.
- Machine Learning: Features xgboost, decision trees, random forests, neural networks, support vector machines (SVM), naive Bayes, predictive modeling, k-means clustering, hierarchical clustering, and functional data clustering.
- Time Series Analysis: Comprises ARIMA, seasonal decomposition, time series analysis, bounds testing, cointegration, auto-regressive distributed lag (ARDL) models, auto-regressive models, and structural time-series models.
- Factor Analysis: Involves exploratory factor analysis and confirmatory factor analysis.
- Descriptive Statistics: Covers descriptive statistics, survey methods, demographics, correlation analysis, data categorization, willingness to pay evaluations, and questionnaires.
- Qualitative Analysis: Includes qualitative analysis, thematic analysis, and interviews.
- Policy and Economic Analysis: Encompasses policy analysis, revenue sharing, luxury tax, municipal ownership, reserve clause, and salary structure analysis.
- Experimental Analysis: Involves experimental design, causal attributions, interaction effects, and analysis of variance (ANOVA).
- Comparative and Nonparametric Analysis: Features comparative analysis, statistical control, imputation methods, counterfactual estimation, average treatment effect on the treated (ATT),

difference-in-difference analysis, dynamic event study, synthetic control methods, Mann-Whitney U test, Kruskal-Wallis test, and non-parametric tests.
- Theoretical Modeling: Includes theoretical analysis, dynamic modeling, infinite horizon models, habit formation, optimal pricing, and identity theory.
- Multilevel Modeling: Comprises multilevel modeling, hierarchical linear modeling (HLM), nested data analysis, and fixed/random effects modeling.
- Network and Sociological Analysis: Features network analysis, egocentric network analysis, social network analysis (SNA), sociological analysis, ritual studies, and first impression studies.
- Geographical and Spatial Analysis: Includes the use of geographical information systems, semivariogram analysis, spatial statistical methods, and spatio-temporal analysis.

Acknowledgements

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ВЛИЯНИЕ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ НА ИССЛЕДОВАНИЯ ПОСЕЩАЕМОСТИ СТАДИОНОВ: ОБШИРНЫЙ БИБЛИОМЕТРИЧЕСКИЙ ОБЗОР

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Аннотация

Эта статья представляет систематический и количественный обзор литературы по посещаемости стадионов с 1980 по 2024 год, с акцентом на трансформационную роль информационных технологий и анализа данных в области спортивной экономики. Мы определяем ведущих авторов, фундаментальные статьи и крупные журналы, используя анализ тенденций, анализ отношений в сети сотрудников, анализ совпадения ключевых слов и методологический анализ для изучения предыдущих исследований. Анализ показывает, что ключевые термины, такие как «спрос», «неопределенность результатов» и «конкурентный баланс», доминируют в области, при этом «общественное здравоохранение» и «большие данные» выходят на первый план как значимые темы. Особо следует отметить введение и растущее влияние техник машинного обучения, которые начали появляться в начале 2010-х годов и стали особенно распространенными в последние годы. Этот анализ не только отслеживает эволюцию технологий анализа данных, но также демонстрирует их глубокое влияние на данную область, особенно в улучшении предсказательных моделей и процессов принятия решений. Исследование завершается стратегическими рекомендациями по интеграции этих технологических достижений для дальнейшего повышения уровня исследований и практики в управлении спортивными мероприятиями. Наши выводы подчеркивают критическую роль инновационного анализа данных в формировании будущего спортивной экономики, что соответствует развивающимся потребностям информационного общества, где такие технологические прозрения становятся необходимыми.

Ключевые слова

информационные технологии; посещаемость стадионов; библиометрический анализ; аналитика данных; управление в спорте

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