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The Business of Sports: An Operations Perspective

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The Business of Sports: An Operations Perspective

Abstract: While sports are enjoyed by several billion fans globally, the business of sports has evolved into a multi-billion dollar industry. Multi-disciplinary research on developing competitive strategies for drafting players and making on-field decisions is growing rapidly. However, there remains a notable gap in operations management research focusing on the *business aspects* of the sports industry. This paper addresses this gap in the literature to encourage future research in this domain. We highlight new opportunities for operations management researchers, emphasizing five research themes that are of importance to the sports industry: (1) revenue management, (2) new technologies in sports business, (3) betting, (4) rule and competition changes, and (5) service operations. We identify important and relevant open-ended research questions and discuss related trade-offs to address the research questions. This paper provides a basis for future operations management research to address the unique challenges faced by sports organizations.

1 Introduction

The sports industry captivates audiences worldwide with excitement, passion, and emotional highs and lows. Sports are broadly celebrated around the world by several billion fans. According to the Fédération Internationale de Football Association (FIFA), the 2022 FIFA World Cup final drew nearly 1.5 billion viewers and generated almost six billion engagements on social media. Major professional sports leagues around the world—English Premier League, Indian Premier League, Major League Baseball (MLB), National Basketball Association (NBA), National Football League (NFL), and National Hockey League (NHL)—boast a fanbase that transcends geographical boundaries and all fan demographics

Beyond the widespread popularity of sports and the excitement of competition, the sports industry is a substantial business. Recent global sports events underscore this financial impact: the media rights sale of the 2022 World Cup alone generated $6.3 billion for FIFA, while the 2024 Paris Olympics contributed an estimated $7.37 to $12.21 billion in economic gains. Further highlighting the industry's economic scale, numerous sports leagues and teams boast valuations exceeding $1 billion, with the Dallas Cowboys leading as the world's most valuable team at over $9 billion (Alfano 2023), while the Indian Premier League (IPL) is valued at approximately $12 billion. In 2022, the global sports industry reached a market size of approximately $487 billion, with diverse revenue streams, encompassing media rights, gate revenues, sponsorships, and merchandising (TBRC 2023). This growth trajectory has a projected compound annual growth rate of 5% from 2022 to 2027, emphasizing the importance of the sports industry (TBRC 2023).

Recent strides in analytics have paved the way for a data-driven approach to decision-making in sports competitions. A well-known use of analytics in sports is the Oakland Athletics (MLB) adoption of analytics-based decision-making in 2002 to identify and draft underrated players who, eventually, well-exceed expectations. A remarkable achievement by the Oakland Athletics in their first year of analytics-based decision-making was their 20-game winning streak, accomplished with one of the lowest budgets among all the teams in MLB (Passan 2018). The success of Oakland Athletics was so impressive that it revolutionized how teams (from MLB and other sports leagues) draft players. This legendary story was later immortalized in the book and film, "Moneyball" which still motivates many professional teams to build their analytics capabilities. After the success of Oakland Athletics, the Moneyball phenomenon has taken over the sports industry. Another recent example is the Philadelphia Eagles (NFL) employing an analytics-based decision-making strategy and winning Super Bowl LII following the 2017 season (Shpigel 2018).

Motivated by the growing impact of analytics in sports, research in sports analytics has seen steady growth over the past few years. Research on this topic has primarily focused on the development and improvement of diverse analytics models to optimize the competitive performance of sports teams. Specifically, analytics is used by sports organizations to build and manage teams, train, strategize, and predict outcomes. A Scopus[1] search using the keywords "sports & teams & analytics" identified 585 papers published between 2010-2023 across fields like statistics, operations research (OR), computer science, and engineering.

The significant economic impact of sports underscores the importance of informed decision-making by leagues, organizations, and athletes. Recent advances in analytics provide sports organizations with tools to assist their strategic decision-making. Despite increasing research focus on analytics to enhance competitive performance, there is a lack of attention from researchers on business-related issues faced by different stakeholders in the sports industry (Gupta and Starr 2017). This gap presents an opportunity for operations management scholars to address the distinctive business challenges faced by sports teams. Our work fills this gap by providing an overview of the sports business landscape, understanding current operations-focused sports research, and identifying critical research areas that operations management researchers can explore. Our work highlights new opportunities for operations management (OM) researchers by identifying key issues in the domain of sports business and discussing how they can be addressed. To do so, we conduct a comprehensive review of operations-focused sports research in top publications, understanding its evolution and using these insights to identify literature gaps and promising directions for future research.

The rest of the paper is organized as follows. In Section 2, we review the current state of operations-related research in key journals. In Section 3, we discuss a framework for future research in this domain. In Sections 4-8, we discuss promising OM research directions in the domain of sports. Finally, we conclude with a summary in Section 9.

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[1] Scopus is an abstract and citation database with more than 36,000 titles from about 11,678 publishers. This database is frequently used by researchers to perform literature reviews.

2 Evolution of Sports Research in Operations Management

2.1 Sports research in FT50 journals

To understand the state of sports-related research in leading business school journals, we searched for research articles in all FT50 journals[2] using the following search words in the title and abstract of the article: sports, tournament, tennis, soccer, Olympics, golf, football, cricket, chess, basketball, and baseball. These keywords are selected to ensure a comprehensive review of relevant literature within the FT50 business school journals, capturing a diverse range of global sports and competitive settings. Given that the intended audience for this paper is primarily operations management (OM) researchers, we further refine our search results by examining the titles and abstracts to identify articles that specifically address operations-focused topics and are relevant to the OM field. This filtering process results in a final selection of 54 articles published across FT50 journals. Among the 54 articles analyzed, there are 20 papers published in *Management Science*, followed by 8 papers in *Operations Research*, 4 in *Production and Operations Management*, 3 in *Manufacturing and Service Operations Management*, and one paper in *Journal of Operations Management*. More details related to the distribution of articles among journals are provided in Table 1. Figure EC.1 (in the e-companion) provides the yearly trend of research articles published over time. We categorize the selected articles based on the specific sports they focus on and this breakdown is summarized in Figure EC.2 (in the e-companion).

Table 1   Operations-focused sports Articles in FT50 Journals

Journal	Count	Journal	Count
Management Science	20	Review of Economic Studies	1
Operations Research	9	Organization Science	1
Production and Operations Management	4	Journal of Operations Management	1
Marketing Science	3	Information Systems Research	1
Manufacturing and Service Operations Management	3	Strategic Management Journal	1
Journal of Marketing Research	2	Journal of Management Information Systems	1
Journal of Financial Economics	2	Academy of Management Journal	1
Journal of Political Economy	2	Journal of Finance	1
		Journal of the Academy of Marketing Science	1
Total: 54			

    Among the papers published in FT50 journals, research has most frequently focused on football (11 papers), followed by basketball (6), baseball (6), and golf (5).[3] Empirical methods using secondary data (30 papers) are the most prevalent. This reflects the availability and extensive use of existing datasets in sports-related research. This is followed by studies employing analytical and optimization techniques (21), which

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[2] FT50 journals refer to the top 50 academic and practitioner-oriented business journals, widely regarded as the leading publications in the field.

[3] Note that 15 out of the 54 articles were not specific to any particular sport.

are commonly used to model and solve decision-making problems in sports business settings. Of the 21 articles using optimization techniques, 10 are published in *Management Science*, 8 in *Operations Research*, and 3 in *Production and Operations Management*. This reflects the close alignment between optimization methods and the focus of these journals in addressing decision-making business problems. Articles using empirical methods involving primary data (2) rely on data obtained through surveys or experiments, and one article utilizes simulation techniques.

After reviewing 54 OM-related sports articles, we identify and classify the papers into six key domains: (1) Behavioral, (2) Betting and Fantasy Sports, (3) Prediction and Training, (4) Process Design, Innovation, and New Technology, (5) Revenue Management, and (6) Tournament Design. These categories represent the breadth of operations-focused sports research in business journals. The distribution of articles across these domains, organized by journal, is shown in Table 2, providing a clear overview of the academic focus within each area. Figure EC.3 (in the e-companion) shows the breakdown of methodologies used in the research domains identified. We observe that analytical research is the main focus of tournament design domain while empirical methods are predominantly used in behavioral and revenue management domains.

Table 2 Research Domains in FT50 Journals

Research Domains and Journals	Count	Research Domains and Journals	Count
Behavioral	**10**	**Process Design, Innovation, & New Technology**	**7**
Management Science	7	Academy of Management Journal	1
Journal of Political Economy	1	Production and Operations Management	1
Review of Economic Studies	1	Organization Science	1
Production and Operations Management	1	Journal of Operations Management	1
Betting/Fantasy Sports	**11**	Strategic Management Journal	1
Operations Research	3	Journal of Political Economy	1
Management Science	2	Management Science	1
Journal of Financial Economics	2	**Revenue Management**	**14**
Information Systems Research	1	Management Science	4
Production and Operations Management	1	Marketing Science	3
Journal of Finance	1	Manufacturing and Service Operations Management	3
Journal of Management Information Systems	1	Journal of Marketing Research	2
Prediction and Training	**5**	Production and Operations Management	1
Operations Research	4	Journal of the Academy of Marketing Science	1
Management Science	1		
Tournament and Ranking Design	**7**		
Management Science	5		
Operations Research	2		

2.2 Sports research in related and domain journals

In addition to reviewing operations-focused sports articles in the FT50 journal list, we also searched other closely related journals to the operations area, namely, *European Journal of Operational Research* (EJOR), *Decision Science Journal* (DSJ), and *Journal of Revenue and Pricing Management* (JRPM).

An initial search for sports-focused research in EJOR, using the same keywords as above, returned over 200 articles. After filtering for articles with a primary focus on operations, we identify 103 relevant publications. Figure EC.4 (in the e-companion) provides the yearly trend of research articles published over time. An analysis of the methodologies employed in these articles reveals that optimization (70) is the most commonly used method (see Table 3 for the full list). We further categorize these articles according to the research domains identified in FT50 journals. The distribution of articles based on the research domains is provided in Table 4. Notably, tournament design is the most prominent research theme in EJOR with more than 60% of the sports-related articles published in the journal. In JRPM, the search returned 12 articles, primarily centered on optimizing ticket pricing in professional sports and enhancing revenue from golf tee-time reservations.

Table 3 Methodologies in EJOR

Methodology	Article Count
Case Study	2
DEA	1
Empirical	19
Optimization	70
Simulation	7
Survey	4
Total	103

Table 4 Research Domains in EJOR

Research Theme	Articles Count
Behavioral	1
Betting/Fantasy Sports	5
Revenue Management	7
Tournament Design	61
Prediction/Training	28
Process Design, Innovation, and New Technology	1
Total	103

To understand the research landscape within sports-focused journals further, we searched the leading sports management journals *European Sports Management Quarterly*, *Journal of Sport Management*, and *Sport Management Review*.[4] To ensure the relevance of the search to operations management, we applied specific keywords, including "Tickets," "Revenues," "Betting or Fantasy," "Optimization," "Stadium Design," "Stadium Location," "Tournament Design," and "Technology." This targeted approach allows us to identify articles that directly contribute to OM practices within the sports journals. The distribution of articles across these research domains is presented in Table 5. Interestingly, our review of articles in sports domains led to the identification of two new research streams, namely Attendance/Viewership/Engagement, and Governance and Regulatory Issues in Sports, that have not been addressed in FT50 journals.

Several books also highlight the role of operations in sports (e.g., Gupta and Starr 2017, Csató 2021). For example, Csató (2021) provide an in-depth overview of tournament design models and their applications, offering valuable insights into this specific area of sports operations. Similarly, Gupta and Starr (2017) dedicate a chapter to sports OM, tracing its historical evolution and categorizing research by different sports. Notably, they observe that much of the existing research has focused on U.S. sports, a trend that aligns

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[4] These journals were selected based on the recommendations of the North American Society for Sport Management and are rated as "A" in the ABDC journal rankings (last accessed 2025).

Table 5 Research Domains in Sports Domain Journals

Research Domains	Articles Count
Attendance/Viewership/Engagement	13
Betting and Fantasy	6
Governance and Regulatory Issues in Sports	8
Revenue Management	40
Process Design, Innovation, and New Technology	29
Total	96

with our findings. This chapter explores topics such as planning and control (e.g., stadium design and capacity planning), enhancing audience experience, and utilizing data to optimize sports outcomes. Our paper broadens this scope to include additional research domains, as detailed in Table 2. Furthermore, we propose a set of specific research questions aimed at guiding operations management researchers in addressing pressing challenges and opportunities within the sports industry. In Sections EC.2 and EC.3 (in the e-companion), we consider each research domain identified in articles published in FT50 and OM-related and sports journals to highlight the current state of research and identify emerging trends.

3 Roadmap for Future Research in Sports Business

The sports industry, with its substantial economic and societal impact, represents a unique and multifaceted domain that has garnered relatively limited attention from OM scholars. The number of academic papers addressing its unique challenges remains relatively low (averaging fewer than four per year over the past five years). This observation serves as the primary motivation for our article, which aims to stimulate operations management research in this underrepresented domain. For OM researchers three general questions emerge:

- What unique and valuable contributions can operations management scholars offer to the sports industry that other disciplines cannot?

- To what extent can we apply insights from the existing operations management literature to the dynamic context of the sports industry?

- What valuable contributions can operations management scholars offer to the sports industry alongside or collaborating with other disciplines?

The research expertise of OM researchers in resource allocation, revenue management, risk management, contract design and coordination, prescriptive analytics models, new technology adoption, public policy, and enhancing customer engagement, can offer a systematic approach to improving the decisions of sports organizations. However, applying existing models and learning from the OM literature to the unique context of the sports industry has challenges. The unpredictable and emotional nature of sports, external factors, short-term performance pressures, and multiple stakeholders with different objectives create complexities that are unique to this industry. Therefore, applying OM principles to the unique environment of the sports industry requires careful consideration of these challenges to ensure practical and effective implementation.

Unlike traditional businesses driven primarily by profit maximization, sports organizations often have multiple objectives. There are several reasons for the multiple objectives of businesses in the sports industry. First, there are multiple stakeholders within the sports industry. The main stakeholders are sports teams, leagues, players, fans including sports gamblers, sponsors, advertisers, media, sports-related businesses including ticket resellers, and government agencies. The diverging priorities of these stakeholders can compete with each other, thereby contributing to the complexity of objectives within the sports industry. Second, sports are driven by competition wherein the teams compete with each other to win championships; likewise, athletes constantly compete with their peers. With competitive pressures and ardent fans, the operations of the sports business differ from those of traditional businesses and consequently face unique challenges. Therefore, for a deeper understanding of the unique aspects of the business of sports, a functional framework of a sports organization is needed to navigate through its complex and conflicting priorities.
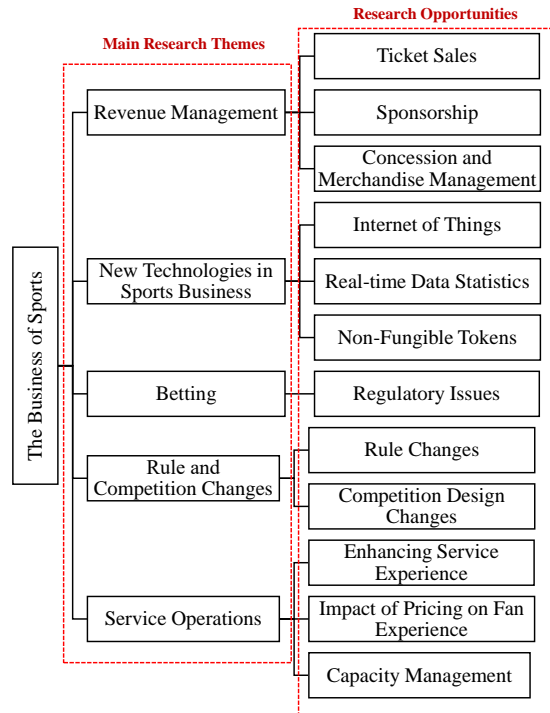
The objectives of sports teams go beyond profits to include winning competitions, building a strong brand, fostering fan loyalty and engagement, and prioritizing player development, among other objectives. These objectives may conflict with each other. For example, a team's strategy to prioritize player development may sometimes conflict with winning immediate competitions, where resource investments in player development hamper short-term team performance. On the other hand, brand building and fostering fan loyalty can often complement each other. Consequently, researchers in this field must recognize the multifaceted objectives faced by sports teams. Furthermore, the goals of league offices such as the NBA, MLB, and NFL diverge from those of sports teams. Specifically, the objectives of the league offices include:

- maintaining the overall profitability of the league (which is also a function of the profitability of individual teams in its league);
- ensuring fan loyalty to the sport, which is vital for the league's success;
- implementing revenue-sharing mechanisms with teams and players, similar to contract and coordination models developed by OM researchers;
- making decisions regarding the location or relocation of teams, analogous to challenges in supply chain facility location;
- keeping competition balanced among teams, because allowing a few teams to consistently dominate could reduce the sport's appeal and drive fans away. To mitigate this risk, many leagues implement regulations (e.g., salary caps) to ensure that all teams remain competitive.

These unique characteristics underscore the need for tailored research approaches that address the distinct challenges of the sports industry while leveraging the robust methodologies of OM.

Building on the insights from the review of operations-focused sports research, we propose a framework of five key research themes that reflect the most pressing challenges and opportunities in the sports industry: (1) revenue management, (2) new technologies in sports business, (3) betting, (4) competition and rule changes, and (5) service operations (see Figure 1). This framework highlights critical dimensions of the

Figure 1 Future Directions in Sports-Related Research in Operations Management

sports business, offering avenues for OM scholars to address the challenges of faced by the sports industry. These themes are discussed in the following five sections, respectively. Our rationale for selecting these themes is grounded in their distinctive relevance to the sports industry. Each theme captures a critical aspect of the industry, offering a lens through which to analyze its complexities. To underscore the unique contributions of OM research, Figure 2 contrasts OM perspectives with those of adjacent fields across these themes. In doing so, we aim to bridge the gap between OM research and the unique dynamics of the sports industry, fostering a deeper understanding of its challenges and opportunities while identifying research questions that OM scholars are particularly well-positioned to address.

4 Revenue Management

Revenue Management is an important domain within OM research that focuses on maximizing revenue from finite resources. Prior OM research within this domain has focused on pricing strategies, overbooking strategies, and demand management. In this section, we provide an overview and discuss opportunities for research under the following three categories: (1) Ticket Sales, (2) Sponsorship, TV and Broadcasting Revenue, and (3) Concession and Merchandise Management.

4.1 Ticket sales

The availability of data related to the demand and supply of both primary and resale tickets underpins the transition of the sports industry from variable ticket pricing to dynamic ticket pricing (DTP). DTP is a

Figure 2 Contrasting OM Perspectives with Adjacent Fields in Sports

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Revenue Management

OM Lens: Designing and evaluating prescriptive DTP models (stochastic demand, bundling, secondary markets) and coordinating outcomes through contracting mechanisms

Other Doman Lens: Marketing (estimating elasticities, shaping consumer perceptions); Strategy (positioning competitively, setting pricing policy).

New Technologies in Sports Business

OM Lens: Designing and implementing new technologies by integrating IoT and sensor data into predictive and prescriptive decision models to enhance efficiency and fairness.

Other Domains Lens: Industrial Engineering (developing devices, optimizing sensors); Medicine (detecting injuries, diagnosing clinically).

Betting

OM Lens: Market design under regulatory constraints, leveraging risk and queuing models to evaluate revenue trade-offs, optimize bookmaking decisions.

Other Domains Lens: Economics (emphasis on regulatory efficiency and welfare outcomes); Sociology (focus on gambling behavior, social norms, and community impacts).

Rule and Competition Changes

OM Lens: Scheduling and queuing models to evaluate how rule changes and tournament designs affect attendance, competitive balance, and tournament outcomes.

Other Domains Lens: Economics (focus on incentives and welfare effects of rule changes); Sociology (focus on cultural meaning and fan identity); Marketing (focus on consumer demand and brand engagement).

Service Operations

OM Lens: Modeling the fan journey (ticketing, parking, concessions, social media) to prescribe service design.

Other Domains Lens: Marketing (measuring satisfaction through surveys); Psychology (examining fan motivation and behavior).

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well-known revenue management strategy, primarily used by hotels and airlines, wherein firms strategically adjust the price over time based on the supply and demand of a product or service. More specifically, in the context of sports, teams change their ticket prices dynamically over time during the season based on the supply of tickets and the demand for the tickets. Among the earliest professional sports organizations to adopt DTP, the San Francisco Giants of the MLB experienced an immediate return on investment; the team reported a 7% increase in overall revenue in the first full season (2010 season) since the implementation of DTP (Shapiro and Drayer 2012). The Giants used a DTP solution developed by analytics software vendor Qcue Inc[5] that tracks resale activities in the secondary market and accordingly adjusts the primary ticket prices based on market demand. Recent research has proposed different dynamic pricing frameworks to estimate the demand for the game, which is then used to price the tickets dynamically (Xu et al. 2019). While sports organizations are increasingly embracing DTP, academic research on the causal effects of DTP and the design of DTP models is still at a nascent stage. To fill this gap in the literature, we specifically propose four research opportunities related to DTP specific to the domain of sports. In the following paragraphs, we first identify the availability and sources of data and then discuss open-ended questions for future research.

Whereas anecdotal evidence points to an increase in ticketing revenue for teams using the DTP strategy, recent empirical research on the impact of DTP in MLB has found no statistically significant effect on game day revenues (Courty and Davey 2020, Xu et al. 2019), perhaps due to the heterogeneity in the implementation of DTP by the teams. Furthermore, firms use different DTP algorithms to update their

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[5] Qcue is a popular vendor and Hawkins (2018) discuss the reasons for this popularity.

prices dynamically and the performance of these algorithms can vary significantly. For example, in addition to the previously discussed DTP by Qcue, Pricemaster by Ticketmaster is a commonly used DTP tool by teams. While the notion of dynamic pricing remains the same, the strategies suggested by the algorithm can significantly affect the perception of the fans, and hence the effect of DTP on game day revenue can vary significantly across the teams. Therefore, a promising research avenue for revenue management researchers is to investigate the heterogeneous effects of different DTP strategies on game day revenue empirically. More formally, OM researchers can explore the following research questions.

- *Impact of DTP Strategy:* What is the impact of DTP strategy on game day revenues? What factors influence the success of the DTP strategy? Answering these questions will not only settle the debate on the impact of DTP but also help sports organizations develop robust ticket pricing strategies.

Despite the growing popularity of DTP, a few teams are still reluctant to adopt it. Wallstreet (2014) reports that 50% of NFL teams are yet to use dynamic pricing and are still relying on either the fixed or variable pricing model. There is a clear traeoff. First, by dynamically updating the ticket prices, teams can strategically price their tickets to meet the expectations of fans, thereby increasing the game day revenue from ticket and attendance, which is also an important metric from a team's perspective. Second, behavioral researchers argue that consumers perceive dynamic pricing to be unfair (Drayer and Shapiro 2011). Hence, dynamic pricing could lead to either lower or higher ticket prices as the game day approaches. On the one hand, a fan who paid for their ticket several months in advance and realizes that the ticket price has decreased as the game day approaches may conclude that it is unfair. This negative perception might have long-term implications, eventually leading to a smaller number of fans purchasing season tickets as they now expect lower ticket prices. On the other hand, a fan who paid for a higher price ticket than the actual face value might also perceive it to be unfair. Third, Arslan et al. (2022) suggest that the inventory of tickets and the number of games could affect a DTP strategy. When the demand for tickets is high, they may be sold out before the season begins, resulting in a limited inventory for the application of DTP (Arslan et al. 2022). This scenario is common in college football where the demand is high for top teams. Future research needs to account for these trade-offs to answer the question of which revenue model (i.e., variable or dynamic pricing) is appropriate for a sports organization. This leads us to the following question:

- *Variable vs. Dynamic Ticket Pricing Model:* Why are some teams hesitant to adopt DTP and what factors affect the decision to implement DTP? More formally, how should a sports organization choose between a variable and dynamic ticket pricing model?

In addition to the tickets sold directly by the teams, a unique characteristic of the sports industry (compared to other industries such as hotels and airlines where DTP is prevalent) is the presence of a secondary market for tickets, wherein ticket holders try to sell the tickets to others. Several platforms, such as Seat-Geek, StubHub, and Craigslist, provide a platform for secondary ticket transactions (Lewis et al. 2019). It is important to note that teams typically do not have any control over the price at which the tickets are sold

in the secondary market. It is often seen that the tickets are sold at a higher price (particularly for popular games) in the secondary market. Furthermore, recent research has shown that, in certain instances, the presence of a secondary market for tickets can be beneficial to a sports organization (Lewis et al. 2019). Consequently, a question that is of interest to sports organizations is as follows:

- *Interaction between Ticketing Platforms and Pricing Strategy:* Will higher prices in the secondary market mitigate the negative perception of DTP? Formally, how should a sports organization deal with third-party ticket vendors and ticket resellers when designing a DTP model?

Ticket bundling refers to the practice of selling multiple event tickets together as a package, at a discount or with added benefits. Ticket bundling, most prominently in the form of season tickets, is universally adopted in the sports industry. Furthermore, many sports organizations release season tickets weeks ahead of single-game tickets as a market segmentation mechanism. Drake et al. (2008) and Duran and Pakyardım (2012) show analytically that such bundling- and timing-based segmentation mechanisms are effective in increasing ticket revenues. Hence, a question that is important to sports organizations is as follows:

- *Pricing Strategy and Ticket Bundling:* How does ticket bundling interact with DTP? In the broader bundling literature that is not industry specific, there is a large body of work that explains when and how firms can profit from bundling (e.g., Geng and Shulman 2015, Geng et al. 2018) and existing research only considers fixed pricing and variable pricing. Given the prevalence of DTP, understanding the interaction of bundling and different pricing strategies is important to sports organizations.

As discussed above, sports organizations rely primarily on third-party ticket vendors, such as Ticketmaster and SeatGeek, to sell their tickets. In addition to serving as a platform for teams selling tickets to fans, these vendors also provide a platform for fans to sell and buy tickets in the secondary market. Our conversations with managers of sports organizations reveal that third-party ticket vendors employ different revenue sharing strategies to generate income in both the primary and secondary markets. For example, Ticketmaster charges a fixed service fee (which is dependent on the actual ticket price) to the sports organizations. In the secondary market, the fans need to pay a service fee as a percentage of the profit they earn on the tickets sold in the secondary market. Thus, Ticketmaster earns revenue from secondary transactions on its platform, and shares a certain portion of the revenue it earns from the secondary market with the sports organization. However, SeatGeek charges the team a service fee which is a fixed percentage of the face value of the ticket but does not share any revenue it earns from secondary sales on its website. Hence, a question that is of interest to sports organizations is which of these revenue models is optimal.

- *Revenue Sharing between Sports Organizations and Ticketing Platforms:* What is the optimal revenue sharing model between a sports organization and a third-party ticket vendor? Although the prior operations literature has studied the benefits of different revenue sharing strategies such as wholesale pricing and agency pricing (e.g., Tan and Carrillo 2017, Geng et al. 2018), the presence of primary and secondary markets raises unique issues in the sports industry.

4.2 Sponsorship

Sponsors of teams have various ways to promote their brands, including traditional stadium signage, naming rights, logos on jerseys, and stadium naming rights. The ubiquity of digital technologies and social media platforms provides both teams and sponsors with another avenue for marketing. In particular, sports teams have among the most widely followed social media accounts. For instance, the New Orleans Saints' Instagram and Twitter pages are followed by more than a million social media users. Sponsors can now leverage the popularity of these social media accounts to market their brands. Likewise, there is an opportunity for teams to monetize their social media pages. Our observation of current industry practices reveals that many digital sponsorship inventories are sold as a free add-on to traditional sponsorship. In particular, if a sponsor buys stadium signage or naming rights, they are provided ad spots on their social media pages. Consequently, questions that are of relevance to sports organizations are as follows.

- *Combining of Traditional and Digital Sponsorship:* How to bundle traditional media sponsorship with the social/digital media sponsorship inventory? This is important to create a common strategy to enhance the team's brand value and engage effectively with the audience.

- *Pricing Strategy of Digital Sponsorship:* How should teams price their social and digital inventories separately? Teams have multiple sponsors, and thus teams need to determine which social media inventory slot should be allocated to which sponsor. In particular, teams need to determine the number of times a sponsor's ad should be placed on their social media pages.

- *Scheduling of Ads:* How should the social media managers of teams determine the optimal schedule for ad placements such that the engagement of fans with sponsors' ads is maximized? The prior analytics literature has demonstrated the importance of scheduling ads on social media (e.g., Kumar et al. 2020, Mallipeddi et al. 2022). Likewise, in the context of sports operations and sponsorship, it is important to develop a comprehensive strategy that can improve engagement with fans.

4.3 Concession and merchandise management

A major function of facilities and event management in sports is to sell additional products to fans who attend games in the stadium: parking services, in-stadium merchandise such as team jerseys, and concessions, including food and drinks. These add-on sales at sports events are often highly profitable – margins on beer and soda sold at games, for example, can be over 90% (Eckstein 2020). Traditionally, in sports events the add-ons are sold separately from tickets. Sports organizations often do not own the facilities where their teams play. For example, in the NFL, only four out of the thirty-two-member teams own their respective stadiums: the New England Patriots, the Miami Dolphins, the Washington Commanders, and the Carolina Panthers. The remaining NFL teams rent their stadiums and thus either do not have direct control over the pricing of add-ons, or are engaged in revenue sharing with the stadium owners (Markazi 2019).

Furthermore, facility owners often outsource their management and operations to third-party event management companies such as ASM Global. The separation of sports team ownership, facility (i.e., stadium) ownership, and event management often imply that the pricing of tickets and add-ons are separate business decisions by different decision makers. However, in professional golf, the PGA Tour has developed a chain of private and public golf courses which are designed for the highest level of professional competition and also their scenic beauty. These 30 Tournament Players Clubs all carry the "TPC" designation. They are mostly owned and operated by the PGA Tour itself, however, five of them are owned and operated by Heritage Golf Group but retain their PGA Tour branding. Among these 30 prestigious courses, 14 are available for play by members of the public, while the remainder provide access through a private membership.

Some sports organizations, however, have started considering add-on sales as an integral part of the fan experience and have experimented with more creative pricing models for add-ons. Below we list two such trends and discuss related opportunities for analytics research. The prevailing pricing model for concessions and parking in professional sports is the add-on model, where a ticket holder needs to spend separately for food, drink, and parking. In recent years, however, some organizations have started offering an alternative all-inclusive pricing model. For example, starting in 2020, season-ticket holders of the San Francisco 49ers have free and unlimited access to a selected list of in-stadium food and beverages (Sanchez 2019).

There is a growing literature that both theoretically and empirically compares add-on pricing and all-inclusive pricing. Several early papers demonstrate analytically that these two pricing choices often result in the same profit for firms in a competitive environment (Lal and Matutes 1994, Verboven 1999, Gabaix and Laibson 2006). Follow-up research largely focuses on identifying situations under which this profit-equivalence result does not hold. On the analytical side, Geng and Shulman (2015), Geng et al. (2018), and Shulman and Geng (2013, 2019) rank firm profits of add-on pricing under a variety of business factors including industrial organization setups, contract types, information disclosure structures and consumer characteristics. This set of analytical papers suggests that a firm's preference between selling add-ons separately and including them as part of an all-inclusive package is highly contingent on the above business factors. Their findings are consistent with business reality where both pricing strategies are widely observed. On the empirical side, Brown et al. (2010), Kosfeld and Schüwer (2017), and Jang and Chung (2021) also find evidence that there is no deterministic ranking between these two pricing mechanisms in the shipping, retail finance, and mobile game markets, respectively. Thus, the existing literature highlights the importance of incorporating industry-specific factors when studying the relative profitability of add-on versus all-inclusive pricing. This opens an interesting research direction.

- *Add-on Pricing Strategy in Sports Business:* Given the significant revenue implications of add-on sales in sports, including concession sales and parking sales, and the fact that some sports organizations are already experimenting with bundled offerings, the following research questions are important. (1)

When deciding between add-on pricing and all-inclusive pricing, what key factors should be considered? (2) What add-ons should be included in a bundle with the tickets, and what should be sold separately? (3) Should sports organizations tailor add-on strategies to different customer segments to maximize both revenue and fan engagement?

Merchandise sales are another important source of revenue for teams. To optimize merchandise inventory levels, teams need to predict their fans' purchase behavior accurately. However, merchandise sales depend on several factors such as team performance, athlete's performance, and weather (Langhorst 2014). Furthermore, customers have heterogeneous purchase behavior. Consequently, a question of interest is:

- *Optimizing Customer Lifetime Value:* How can a team predict a customer's journey to optimize merchandise inventories? Given that teams now have access to real-time data, this calls for an automated and seamless data acquisition process that allows a sports organization to pull and integrate data from a wide range of sources. For example, fragments of fan engagement data may reside in multiple channels including team and league websites, third-party ticket sales repositories, and various social media sites. Combining data from different sources, future research can build data-driven analytics models to predict customer purchase behavior and optimize their merchandise inventory levels accurately.

5 New Technologies in Sports Business

OM researchers have been at the forefront of research studying the effect of new technologies on a wide variety of outcomes. The sports industry is continuously evolving with new technologies that enhance both athlete performance and business operations. In this section, we discuss three such new technologies related to the sports industry and their impact on the business of sports.

5.1 Internet of Things

Recently, the integration of IoT (Internet of Things) and wearable technology in athletic training have opened new avenues in OM and Business Analytics. These technologies generate vast amounts of data that, when analyzed effectively, leads to better-informed decisions. This convergence of technology and data analytics is transforming how athletes train, how coaches make decisions, and how organizations manage their sports teams. A prime example of this is the use of wearable devices in soccer. Teams such as Manchester City utilize GPS trackers during training sessions and matches to monitor players' movements, speed, and workload. This data helps coaches and analysts understand each player's physical performance and fatigue levels, allowing for personalized training regimens and optimal game-time decisions. For example, if a player has a higher risk of injury due to overexertion, coaches can adjust the intensity of training rest the player, preventing injury and prolonging careers. The use of smartwatches and fitness trackers is prevalent among endurance athletes such as runners and cyclists. These devices not only monitor heart rate and distance but also track metrics like VO2 max, an indicator of aerobic capacity. With this data, athletes can

monitor their progress over time, adjusting their training regimens to optimize their conditioning and competitive edge. Wearable technology also plays a crucial role in injury prevention and recovery. For example, athletes involved in high-impact sports like football or rugby use smart compression garments equipped with embedded sensors. These garments measure muscle strain and impact forces, providing early warnings of potential injuries. If sensors detect excessive strain or abnormal patterns, coaches can modify training loads or techniques to prevent injuries before they occur. In the context of Business Analytics, these data sets provide an opportunity for deeper analysis through machine learning and predictive analytics. For instance, algorithms can predict an athlete's performance trajectory, identify potential performance issues before they arise, and recommend personalized training adjustments. This application of advanced analytics transforms the data collected into actionable insights, allowing for continuous improvement in athlete performance. Overall, the use of IoT and wearables in athlete training not only enhances performance but also offers a competitive advantage. Teams that effectively leverage these technologies and data analytics can make more informed decisions, leading to better outcomes both on and off the field. As the technology and analytical methods continue to evolve, the potential for further advancements in athlete performance optimization is immense, making this an exciting area of growth in OM and Business Analytics.

Leveraging the expertise of OM researchers in healthcare analytics, data-driven solutions can be developed to predict health risks, optimize recovery processes, and improve athlete outcomes. Thus, OM researchers could explore the following research question.

- *Adoption of IoT and Healthcare Analytics:* How can IoT wearables be effectively utilized to monitor and enhance recovery protocols for injured athletes?

5.2 Real-time data statistics

Despite the social and financial importance of sports, recent surveys point to dwindling interest in sports and viewership. A Deloitte (2023) survey reports that 71% of all fans consider live sporting events as their preferred form of consuming sports content. However, only 58% of Gen Z (i.e., those born after 1996) and Millennial (i.e., those born between 1981 and 1996) fans consider it as their favorite type, which indicates a decline in consumption of live sporting events compared to broader sports experiences.

Recent advances in technologies, such as IoT devices, artificial intelligence (AI), and cloud platforms facilitate the collection and assembly of large volumes of data at a granular level. Using these technologies, sports teams capture precise data related to players' actions, locations, and movements and use this information for on-field decision-making. This data can also be utilized by stadiums and streaming/television networks to enhance the viewing experience and audience engagement (NTT Data 2023). Each sport has its own data platform that broadcasters and stadiums can utilize to enhance viewership and better connect with the fans, especially Gen Z fans. Examples are listed below, with data sources in Section EC.6 (in the e-companion).

- *NFL Next Gen Stats:* Through the NFL Next Gen Stats (NGS) program, the NFL tracks and captures thousands of data points on each play. According to the NFL, its NGS program "captures real-time location data, speed and acceleration for every player, every play on every inch of the field." The NGS program tracks player data through radio-frequency identification and IoT devices placed in players' shoulder pads, footballs, and in the stadium. The NFL provides NGS data to all the teams each week. The NGS data includes data related to the team's offensive plays such as: receivers' speeds and routes, time taken by the quarterback (QB) to throw, speed of the ball thrown by the QB, and rushing efficiency. The judicious release of such information enhances fan value and betting opportunities.

- *MLB StatCast:* StatCast is MLB's program for collecting and analyzing data related to baseball. Using radars and cameras coupled with "Hawkeye" technology, teams now have access to data for each pitch thrown during a baseball game. In the 2020 regular season, MLB collected hundreds of data points on more than 260,000 pitches, including the batter's launch angle (i.e., the angle at which the ball comes off the bat), exit velocity (the speed at which the ball leaves the bat), pitch velocity (the speed of the ball thrown by a pitcher), and spin rate. This information can also enhance fan value.

- *NBA Advanced Stats:* Data-driven analytics has transformed the NBA so that the game is completely different from a few years earlier (Stein 2019). To reap the benefits of data, Brooks (2020) reports that the NBA is expected to spend more than $250 million dollars to develop the NBA Global Statistical System (NGSS). NGSS provides teams and fans with a wide breadth of data, including the number of shots taken, spatial information on where the shots were taken from, and NBA players' movements.

- *Golf and Big Data:* Golf is one of the earliest sports to adopt big data (Arastey 2020). Since 2003, the PGA Tour has started to collect several data points on every player's stroke, including speed, distance, coordinates, and players' mechanics. This data is not only used by the players to improve their performance but also by fans and broadcasters. For example, before a player putts, broadcasters can use data and models to predict the probability of the ball making it into the cup (Wong 2020). This use of data to provide additional information to the audience can significantly improve the viewing experience and is seen as crucial for the sport to widen its fanbase. (Wong 2020).

- *Tennis:* Several platforms, such as the Infosys Tennis Platform[6] and Clutch[7], provide tennis players and their teams with tools to analyze data. Hawk-eye technology uses multiple cameras to capture and predict the trajectory of the balls (UBITENNIS 2021). Wimbledon has embraced this technology to provide an enhanced fan experience both at the stadium and on TV. The following statement by the Marketing Director for The All England Club underscores the importance of embracing technology: "*We are constantly innovating with our partners at IBM to provide Wimbledon fans, wherever they*

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[6] https://www.infosys.com/atp/tennis-platform.html

[7] https://www.clutchapp.io/

are in the world, with an insightful and engaging digital experience of The Championships. This year,
we're introducing new features for our digital platforms that use the latest AI technology from IBM to
help fans gain even more insight into the singles draw and access commentary on a wider variety of
matches through our match highlights videos" IBM (2023).

Broadcasters are increasingly leveraging data to enhance viewership and better connect with the fans, especially Gen Z fans. One example is the NFL on Amazon Prime. Amazon (2023) reports that 63% of its viewers are Gen Z and Millennial fans compared to 45% of viewers of traditional television broadcasts. Amazon has taken steps to connect better with a younger audience, for example using AI-based predictions to predict plays. Specifically, games broadcast on Amazon Prime leveraged data from NGS and gave the streaming audience AI-generated predictions of defensive strategies before each play (Nguyen 2023).

While new technology is viewed as a means to attract a younger audience to the sport, the causal impact of these technologies is not yet established in the literature. This presents an opportunity for OM researchers to study the following research questions.

- *Technology and Viewership:* What is the impact of AI-based tools on attracting new fans to sports? How can leagues, teams, and broadcasters leverage new data and technology to engage with their fans?

5.3 Non-Fungible tokens

A recent development in the sports industry is Non-Fungible Tokens (NFTs), which have rapidly risen to prominence, emerging as a vital element in redefining fan engagement and opening new avenues for revenue generation. In this section, we provide an overview, exploring the transformative effects of NFTs in the sports sector. We examine how these unique digital assets are reshaping interactions between fans and sports entities, and how they are creating business opportunities in the realm of sports operations.

NFTs are unique digital assets verified using blockchain technology. They are usually stored on Ethereum, which is a decentralized blockchain. This provides a transparent history of the NFT's ownership and authenticity. Unlike fungible tokens like cryptocurrencies, which are identical and interchangeable, each NFT is distinct and cannot be replicated. Each blockchain-based token represents a unique asset of digital content (Shang et al. 2023). This uniqueness has made NFTs particularly popular in digital media, where they are used to buy, sell, and trade ownership of unique digital creations.

In the sports industry, NFTs have emerged as a new way for sports fans to engage with their favorite leagues, teams, and players. Deloitte Global estimates that NFTs for sports media can generate more than US\$2 billion in transactions in 2022, and around 5 million sports fans globally have an NFT sports collectible (Lee et al. 2022). According to PWC, the major applications of NFTs in sports include digital collectibles and memorabilia, innovative ticketing solutions, and fan tokens in the metaverse, each offering unique ways to enhance the sports fan experience. Collectibles and memorabilia are important revenue

sources for sports teams and athletes. In the digital realm, these entities are capitalizing on this by releasing NFT versions of popular sports memorabilia. Such offerings range from digital trading cards and virtual trophy replicas to captured moments of sporting glory, all available for fans to purchase, collect, and exchange. The market for these authenticated, limited-edition digital collectibles is thriving, with NBA Top Shot by Dapper Labs emerging as a prominent example. Highlighting the growing interest in this space, Tom Brady's NFT venture, Autograph, recently secured $170 million in a Series B funding round (Quiroz-Gutierrez 2022). These collectible NFTs, often officially licensed by leagues, teams, or individual athletes, are the digital era's equivalent of traditional trading cards. They offer sports organizations a lucrative opportunity to connect with a tech-savvy fan base.

The adoption of NFTs for ticketing is also changing the way sports events are accessed and experienced. NFT ticketing offers a secure, digital alternative to traditional paper or standard electronic tickets. Each NFT ticket is a unique proof of purchase and collectible item, often featuring exclusive artwork or content related to the event. This uniqueness ensures authenticity and combats unauthorized resales (Katz 2022). Additionally, NFTs enhance the fan experience by embedding special perks or access to exclusive content, such as behind-the-scenes footage, meet-and-greets, or special event memorabilia. The integration of NFT ticketing also opens new revenue streams for event organizers through secondary sales; smart contracts can be programmed to provide a percentage of resale value back to the original issuer. This digital shift in ticketing is a strategic move toward creating a more engaging, secure, and versatile event experience for fans. Further, as Keenan et al. (2022) suggest, the combination of the metaverse with NFTs can create an entirely new marketplace. The use of NFTs in sports has implications both within and outside games. Within games, NFTs can provide fans with an exclusive viewing experience, offering access to unique content like player, bench, or locker room cams for those unable to attend games in person. This limited-access approach gives fans a more immersive connection with the sport. Outside games, NFTs can unlock unique digital experiences for fans, for example the ability to revisit exclusive content, including private interactions with coaches and players. Such access facilitates direct and meaningful engagement between fans and teams. This integration of sports into the metaverse via NFTs is a redefinition of fan engagement, creating a new dimension where the digital and physical worlds of sports fandom converge.

While NFTs offer considerable potential for the sports industry, the future of NFTs in the sports market may still face some uncertainty, particularly given the recent downturn in the broader digital asset market. NFTs overall have witnessed some market softening, characterized by reduced sales, declining activity, and a notable decrease in market value for various assets (Bochan 2023). This shift poses challenges for NFTs within the sports industry, suggesting a need for strategic adaptation to evolving market dynamics. Enhancing the appeal of digital assets in sports hinges on establishing a tangible link between these assets and distinct benefits for fans. NFTs should offer added utility, functionality, and redeemability. Specifically, from an operations perspective, the sports industry should focus on addressing the following key issues.

- *Effective Integration with Fan Loyalty Programs:* How can NFTs be more seamlessly incorporated into existing fan loyalty programs, thereby creating a cohesive bridge between the physical and digital realms? This integration needs to be executed in a way that enhances the fan experience, adds value, and maintains the essence of traditional loyalty incentives.

- *Increasing Awareness and Accessibility:* How can leagues and teams boost awareness and minimize entry barriers for fans by weaving NFTs into already popular fan engagement channels? This includes leveraging platforms such as mobile apps, gaming environments, and social media networks. The challenge lies in making these digital assets easily understandable and accessible to a broad fan base, ensuring that they complement rather than complicate the fan experience.

Answering these questions is crucial for the sports industry to harness the potential of NFTs fully. Doing so will not only enhance fan engagement and loyalty but also lead to new avenues for revenue generation and market expansion. The key lies in striking a balance between innovative digital strategies and the traditional values that have long been the foundation of sports fandom.

6 Betting

LSports (2024) provides a global overview of the regulation of sports betting. In the U.S., sports betting is regulated at the state level, following the Supreme Court's May 2018 decision in *Murphy vs. NCAA*. There are big differences between states, for example New York allows betting only on in-state events, whereas Nevada has no such restrictions. Canada followed a few years later by allowing betting at the provincial level. In Europe, sports betting is more heavily regulated, with a strong licensing requirement in France, and a high tax rate on sports book's profits. Colombia leads the rapidly growing sports betting market in Latin America. In both Africa and Australia, levels of regulation are much lighter.

In-play betting offers the attraction of an immediate win and the excitement of rapidly changing odds, and is increasingly popular. In Europe, in-play betting accounts for more than 50% of all sports betting, whereas in the U.S. it is just below 50%. In-play betting provides bettors with a vast array of small events during a sports game. This generates a high frequency of betting outcomes and the ability to accumulate and reinvest winnings. National Council on Problem Gambling (2018) provides a review of sports wagering and gambling addiction studies. Data from 2018 shows that more than 75% of students gamble. Males are far more likely than females to gamble and incur addiction issues. Higher fantasy game participation is associated with more severe gambling problems. Aggressive advertising, including "free play" and "risk-free bonus" make it harder to stop gambling. For example, Ohio's Problem Gambling Network experienced a 55% increase in call volume in 2023, the first year of legalized sports betting in the state. Torrance (2022) studies the behavior of 225 in-play sports bettors in the U.K. The most emotional bettors used the instant cash feature the most, a catalyst for harmful gambling behaviors. Additional features frequently used by such bettors were statistics boards and live updates, which lead to a false perception of advantage.

Sportradar Integrity Services (2023) provides a comprehensive review of recent betting-induced corruption, i.e. match fixing, in sports. Sportradar's AI-assisted Universal Fraud Detection System (UFDS) identified 1,212 suspicious matches in 12 different sports across 92 countries in 2022. This activity occurred in 0.21% of matches overall, with soccer at 0.59% and basketball at 0.51% being the most suspect sports. The UFDS works with 400+ sportsbooks globally, analyzes data from 16.5m bets per day, and tracks 500 data points per match. More than 30 billion odds changes are tracked annually; 82% of suspicious cases involved in-play betting, and within this group 77% occurred during the first half of a match. Among suspicious incidents, 49% involved betting against the spread, 25% were betting of "over", and 8% were betting of exact scores. The last of these is especially concerning, since it would involve corruption by both teams. Also, betting of over is vulnerable to referee manipulation, for example by generously awarding penalties to either side, and indeed referees were implicated in 8% of all cases. Europe was the most affected region with 630 cases, followed by Asia with 240 and South America with 225. North American sports generated only 24 suspicious incidents, however the broader legalization of betting may result in more match fixing.

The days when sports teams declined to partner with betting organizations on ethical or moral grounds are mostly over. An overview of recent collaborations is provided by Easy Reader News (2023). In 2019, the NFL formed a partnership worth $30m per year with Caesar's Entertainment. Additionally, betting leaders DraftKings have partnerships with the New York Giants and Philadelphia Eagles, and its rival FanDuel partners with the Denver Broncos and the Washington Commanders. Overall, at least 18 NFL teams have similar collaborations. A unique collaboration between Unibet and the Philadelphia Eagles includes the release of a series of sports-related casino games, Eagles Blackjack and Eagles Slots (O'Connor 2019). In the NHL, William Hill has partnerships with the Las Vegas Golden Knights and the Washington Capitals. In the NBA, PointsBet has collaborations with the Denver Nuggets, Detroit Pistons and the Washington Wizards. In MLB, MGM has partnerships with the Boston Red Sox and the Washington Nationals. Betting organizations are also targeting universities, for example Caesar's Sportsbook offered a deal to Michigan State University worth $8.4m over five years to market their services to the campus community.

Deloitte.com (2023) summarizes developing trends and risks in a maturing sports betting market. On the positive side, as discussed above, there are the increased economic opportunities and fan engagement that sports betting delivers. These appealing features need to be measured against potential drawbacks related to addiction, corruption, illegal betting, and financial crime. Since the U.S. is not the first mover in legalized betting, it should be possible to learn from countries with greater experience. There is a tension between short-term profitability and the long-term health of the sports betting industry, especially considering the possibility of an economic recession. Betting operators should be incentivized to ensure the long-term health of their industry and of its potential customers, the betting and sports watching public. OM scholars can explore the following research questions as proposed by Deloitte.com (2023).

- *Sports Betting and Legislation:* How would consumer protection legislation affect the revenue potential of sports betting?

- *Strategy in Regulated Environment:* What is the best marketing strategy for sports book operators in an increasingly regulated environment?

7 Rule and Competition Changes

In Section 7.1, we discuss recent rule changes in sports. In Section 7.2, we discuss recent major changes in sports competition design. Both sections contain several suggestions for future research. A concern that affects both changes is disinterest among younger people. For example, one-third of the Gen Z demographic - those born between the late 1990s and the early 2010s - do not watch live sports, 38% don't have a favorite team, 47% have never attended a professional sports event, and 60% have never attended a college game (Kirschner 2023). As he notes, the entertainment options that compete with professional sports have changed from 30-minute television shows to 15-second videos, as a result of social media and streaming services. Hence, sports need to adapt their entertainment strategies to ensure their future audience.

7.1 Rule changes

As discussed by Encel and Phillips (2023), there are four main reasons for rule changes in sports: (a) to reduce injuries, (b) to make the game fairer or easier to officiate, (c) to enhance entertainment, and (d) to increase opportunities for advertising or other revenue enhancement. Items (a) and (c) often conflict.

Major League Baseball introduced several important rule changes for the 2023 season to enhance the spectacle of its games. These include, firstly, a pitch timer (15 seconds with bases empty, 20 seconds with runners on base). The motivation here is to speed up play, especially to improve the game's appeal to younger people. The effect has been substantial, from 3 hours 6 minutes to 2 hours 39 minutes in average game time. Secondly, an increase in base size from 15 inches square to 18 inches square should encourage base stealing and reduce injuries. A substantial increase in stolen bases from 1.02 to 1.42 per game has followed. The success rate is 80% compared to 74% in 2022. Thirdly, banning of the unbalanced outfield or "defensive shift' is intended to encourage more exciting running plays and more scoring, and resulted in an average increase of 1.4 runs per game. No significant loss in concession sales has been observed from the shorter games. MLB Commissioner Rob Manfred has been quoted as saying, "There was no decrease in our concession sales". He explained this as fans previously leaving after six or seven innings, whereas, "Now they stayed until the end of the game." Indeed, CrowdIQ reports that typically 90% of fans remain at a game after 2 hours, and 80% after 2.5 hours, whereas after 3 hours only 60% remain.

The NFL introduced several rule changes for the 2023-2024 season. Lowering the helmet for a hit results in an immediate penalty. Legendary quarterback Tom Brady has commented, "There are so many people who want it less physical. It's becoming more like flag football . . .". Similarly, a kickoff alignment is used

to reduce injuries due to high closing speed of the two teams running at each other. The estimated effect of the last rule change is a 15% reduction in concussions associated with kickoffs.

Fans of NBA basketball have expressed frustration with star players choosing to sit out for a substantial number of games during the long 82-game season, in some cases for minor or poorly defined injuries. This is potentially damaging to team revenues and the reputation of the sport. As a result, starting in the 2023 season, a rule was implemented whereby players needed to play in at least 65 of the 82 games in order to be eligible for regular season awards. The NBA Commissioner, Adam Silver, commented, "When I see young, healthy players who are resting, it becomes even more of a notion of stature around the league".

Several rule changes for NCAA football (Hamm 2024). These include a two-minute warning at the end of each half, coach-to-player helmet communication, and the use of tablets on the sidelines by players and coaches as already allowed in the NFL. The first change will allow greater opportunity for commercial breaks. The second and third changes reduce the use of communication by signs, representing a desire to improve the integrity of the sport following allegations of sign-stealing by the University of Michigan in 2023. In the Australian Football League in 2021, advertising breaks that follow a goal were extended from 45 to 60 seconds. While this may be positive for player health, a major motivation seems to be increased revenue. In professional cycling, in 2024 the governing body UCI developed a cumulative yellow card system for violations, to improve the integrity of the competition. To reduceinjuries during a crowded rush to the finish line, riders who finish within three seconds of the leaders are given the same finish time (Weislo 2024). In Formula One racing, perpetual concerns have been safety and a lack of overtaking opportunities that reduce the excitement and competitiveness of the event. In response, the governing body F1A has unveiled a set of "agile, competitive, safer and more sustainable" regulations that will be in effect from 2026 (Barretto 2024). These include active aerodynamics in the form of movable front and rear wings, and the introduction of a new system that gives drivers additional power when within one second of the car in front.

OM researchers should explore the following research questions.

- *Changes in Rules:* (1) How will the further 2024 pitch clock change from 20 to 18 seconds affect game time and team revenues? (2) How will perceptions that NFL games have become less physical affect viewership and advertising revenues? (3) How will the changes to cycling rules affect team strategies and the frequency of injuries? (4) How will the changes introduced in Formula One racing change the frequency of overtaking in Grand Prix events? (5) How will the March 2025 NFL proposal to ban the short yardage "tush push" play used by the Philadelphia Eagles affect game strategies?

7.2   Competition design changes

Competition design changes are usually motivated by perceptions of loss of integrity, such as incentives for shirking, or by opportunities for revenue enhancement. For example, playoff expansion has occurred in several professional sports, which keeps fans of more teams engaged longer through the season.

Recent FIFA World Cups have invited 32 teams in eight groups, resulting in up to $8 \times 6 = 48$ preliminary round group matches and 16 knockout matches, for a total of 64 matches. The originally announced tournament design for the 2026 World Cup with 48 teams had 16 groups of three teams each, with the top two teams from each group advancing to the knockout stage. Under the proposed design, there would be $16 \times 3 = 48$ group matches and 32 knockout matches, for a total of 80 matches, a 25% increase over the previous events. However, this design attracted substantial criticism. The single team that does not play in the first of the three group matches may be disadvantaged since if a team they later play against won their previous game, they will be motivated to shirk and play for a draw, which will be sufficient for them to advance to the next round. Motivated by this criticism, and possibly anticipating further revenue expansion, in March 2023, FIFA announced a revised tournament design with 12 groups of four teams each, resulting in $12 \times 6 = 72$ group matches and 32 knockout matches, for a total of 104 matches. The possible effects of this change on the physical stress on players have been the subject of media commentary.

Before the 2020 regular season, the NFL changed its playoff design, from seven to six teams per conference. The justification provided was that there would be more excitement, more interest, more chances to win the Super Bowl - and of course, more revenue. A survey by SB Nation asked fans in advance whether this would make the playoffs better or worse, and only 43% responded "better". In the first three years under this new design, the newly introduced No.7 seeds have lost all their six games, by 3,12,21,16,3 and 18 points. Based on these statistics, it would be difficult to argue that the playoff expansion generated improved competition. Nonetheless, a follow-up survey by SB Nation after the 2021 season found that 57% of respondents now felt that the new design was an improvement. Additionally, the revenue enhancement to the NFL from staging the two extra games is estimated at $150m annually. Similar playoff-expansion changes were implemented by MLB in 2012 with a wildcard team in each league, offering new revenue opportunities.

Within college sports, athletic conferences in the NCAA are realigning, especially in the most financially important sport, football. Traditional powerhouses Oklahoma and Texas moved from the Big 12 conference to the SEC. The Big 12 admitted four schools to restore their strength, including three from the AAC. Both UCLA and USC moved from the Pac-12 to the Big 10 in 2024. One motivation is improved access into the expanded playoff structure in NCAA football, from 4 to 12 teams, with effect from the end of the 2024 season. Second, more powerful conferences are able to command massive media rights agreements; for example, Fox, CBS and NBC (including Peacock) signed a $7 billion deal with the Big 10 to run for seven years from July 2023. However, as reported by Baker (2022), a study of 2012-2015 conference realignments showed that, for 45 out of 47 schools studied, there was no increase in revenue, no drop in expenses, no improvement in football performance, no increase in student applications or quality, and no improvement in graduation rates. This may be due to a unique characteristic of college athletics, that traditional rivalry games are some of the most popular events, for example, with alumni and other team boosters.

The PGA TOUR is the main men's professional golf tour in N. America, with a 2022 revenue of about $1.5 billion, of which $838 million was distributed to its (175, plus some exempted for injuries) players. However, a rival organization emerged when the Public Investment Fund of the Saudi government, with assets of $620 billion, started LIV Golf, which attracted several leading players through generous signing bonuses, less play, guaranteed money, and larger prizes. The PGA TOUR has for many years enjoyed a monopoly on top level professional golf in N. America, and given over $3 billion donated to local charities. However, some players believe that the PGA TOUR has not properly shared their wealth with their players, especially the top players. LIV players are currently excluded from PGA TOUR events (with the four Major Championships as exceptions) and do not earn world ranking points, which would eventually make them unqualified for the main events. An initial "framework agreement" for a merger between the two tours was announced on June 6, 2023, however, almost two years later, no details are yet available.

Hall and Liu (2024) observe that opponent choice is used in several professional sports tournaments, including by the Austrian Ice Hockey League, the U.S. Bridge Federation, and the PRO Chess League. They study the use of opponent choice in sports tournament design generally, with an application to men's tennis. Their extensive simulations demonstrate advantages in reliability of results, fan interest, and reduction of shirking. Hook (2020) provides details of a preliminary proposal to expand the U.S. Major League Baseball playoffs to include additional teams, and permit higher ranked teams to choose their opponents.

OM researchers should explore the following research questions.

- *Changes in Competition Design:* (1) How will the large increase in games for the 2026 World Cup affect revenues and player health? (2) How will the significant realignments taking place in NCAA conference structure affect revenues and fan interest, especially when traditional rivalry games are discontinued as a result? (3) How will the March 2025 proposal to redesign the seeding of the NFL playoffs to prioritize overall rather than in-division performance affect playoff results? (4) How will the ongoing fight between the PGA Tour and LIV affect fan interest and TV audience size? (5) Will MLB and possibly other major sports consider opponent choice as a workable option for their end of season playoff, and if they do so, what will be the effects on tournament integrity and spectacle?

8   Service Operations

Our review of the literature in sports management journals identifies the audience experience domain as a critical area of study. Research in sports management has extensively examined the impact of factors such as team composition, the presence of star players, and anticipated outcome uncertainty on stadium attendance and television viewership. Heim and Ketzenberg (2011) highlight the importance of the audience experience by examining how golf course design changes influence customer expectations, further underscoring the role of service design in shaping fan engagement and satisfaction. Recognizing the importance of this topic in sports management and the expertise of OM researchers in the domain of service operations, we propose a future research agenda that OM researchers can explore to contribute to this topic.

8.1 Enhancing service experience

One prominent feature of sports is that the fan experience goes beyond the time spent in stadiums. For a single game, a fan's journey includes ticketing, purchase of merchandise, commuting to the venue and parking, possibly a tailgating party, the game, and possibly postgame social activities. Nowadays, sports organizations are able to collect far more data on the fan's journey than before, thanks to advancements in traceable digital ticketing, mobile apps with location tracking, and social media data mining (Arkenberg et al. 2019). The prevalence of digital tracking tools has enabled teams to understand the behavior of the fans in real-time, which can help teams collect rich data that can be used to generate prescriptive solutions to enhance the experience of their fans. This unprecedented data access opens up several new research opportunities concerning fans' purchase behavior and in-stadium and off-stadium fan experiences.

In addition to enhancing fans' experience in the stadium, sports organizations are also exploring ways to improve engagement with fans outside of the stadium (during both game days and non-game days). Prior research has shown that engagement has a positive impact on visibility (Mallipeddi et al. 2021) and customer purchase behavior (Kumar et al. 2018). However, the literature on the effects of fans' engagement in the context of social media is unclear. Therefore, questions that future research should explore are as follows.

- *Enhancing Experience:* (1) How effective are off-stadium experiences in improving fan satisfaction? (2) How does this effectiveness differ among off-stadium experiences? (3) Are in-stadium and off-stadium fan experiences complements or substitutes in driving fan satisfaction regarding a single game and in driving long-term fan loyalty? Answering these questions can improve fans' experiences.

8.2 Impact of pricing on fan experience

The relationship between pricing and fan experience plays a critical role in sports management. Drayer and Rascher (2013) provide a comprehensive review of research exploring how pricing strategies influence various dimensions of the fan experience. Some sports organizations also started looking at using concession pricing as a tool for delivering a better fan experience. In 2017 and in an effort to improve fan satisfaction, the Atlanta Falcons broke from the long NFL tradition of high markups on concessions and slashed its food and beverage prices by 50%. By early 2018, it became clear that the Falcons' strategy had paid off: compared to the previous season, in 2018 "an average of 6,000 more fans showed up an hour before the game," a strong signal that the in-stadium fan experience improved significantly (Sankofa 2018). Moreover and surprisingly (as acknowledged by the chief operating officer of the Falcons' holding company), the total sales on concessions increased 50% as compared to one year earlier despite the steep price cut. The news of the Falcons' success spread quickly across the world of professional sports, and at least two other teams are considering a similar move (Sankofa 2018). This new development that links concession pricing with fan experience opens up many research opportunities.

- *Concession Pricing and Fan Experience:* How to measure the (causal) relationship between concession pricing and fan experience? What is the optimal tradeoff between margin reduction and the sales increment for concessions? Will a similar positive relationship between add-on price cut and fan experience improvement hold for parking, which has less elastic demand than food and beverages?

8.3 Capacity management

Capacity management is a fundamental concept in OM, focused on optimizing resource utilization and enhancing efficiency, and thereby improving customer satisfaction. In the sports business, athletes represent one of the most critical resources for teams, and effectively managing this resource ensures that organizations maintain the necessary capacity to meet both current and future performance demands.

Prior research has studied the issues of drafting decisions and optimal team composition (e.g., Fry et al. 2007, Hellingman et al. 2025). Furthermore, effective recovery management is important for minimizing injury risk and improving athlete performance. Halson (2013) discusses recovery strategies in sports contexts. Additionally, the OR literature looks at prediction and training models in different contexts. A detailed discussion of this literature is provided in the e-companion (Section EC 3.6).

Our discussions with an NBA team reveal that franchises are increasingly implementing "load management" strategies to optimize player workload, to improve performance, and extend the careers of star athletes. As part of load management, teams may rest star players during lower-stakes games to reduce injury risk and ensure optimal performance during crucial stages of the season. However, this is widely cited as a reason for the recent TV ratings slump of the NBA (Thorne 2022). Hence, teams need to understand and carefully navigate the trade-offs between optimizing on-field performance and maintaining a high level of fan satisfaction. While this is an important problem from an industry perspective, it has not received attention in the literature. The following research questions are relevant for OM scholars:

- *Capacity Management in Sports:* What is the impact of load management on fan experience in the stadium and at home? How does load management affect short-term team performance and long-term financial outcomes (e.g., ticket sales, merchandise, and media revenue)?

9 Concluding Remarks

Beyond the competitive fervor of fans, sports is a serious business with annual revenues nearing $500 billion globally. Given a shrinking fan base, new technologies, and competition from alternative options such as "esports", sports organizations must leverage the power of data and decision-making tools to optimize their decisions. Our work develops a functional framework to navigate the unique, yet complex, business operations of sports organizations. We focus on five research themes: (1) revenue management, (2) new technologies in sports business, (3) betting, (4) rule and competition changes, and (5) service operations. Within each of these themes, we discuss the role of OM researchers. The proposed research questions are

summarized in Tables EC.12–EC.16 (Section EC.7 of the e-companion), where we map them to relevant OM methodologies and provide references to prior literature for each question. We provide a discussion on key directions to advance understanding of the unique business problems that arise within the sports industry for OM researchers. By highlighting key research themes and presenting open-ended questions, our work encourages scholars to delve into unexplored domains of research, contributing to the advancement of knowledge within the evolving business of sports. Several themes in our framework are linked by cross-cutting dimensions that underscore the interdependence of OM decisions in sports. Capacity management affects not only ticket sales but also fan engagement and service design, where scheduling and queuing influence the fan journey. Data ethics is central to both the adoption of new technologies and the integrity of betting markets. Coordination spans rule changes, betting, and service operations, requiring alignment among leagues, teams, regulators, and fans. These connections highlight how OM research can provide an integrative framework for addressing the complex challenges of the sports industry. While our primary focus has been on the operational aspects of business, there are several cross-disciplinary and emerging topics present promising avenues for revenue. We discuss these in the following subsection.

9.1 Emerging cross-disciplinary issues in sports

Beyond its substantial economic impact, the sports industry promotes positive societal outcomes. Sports-related industries generated over 5.6 million jobs across Europe (EU Publications 2014). Moreover, sports act as a unifying force, strengthening community ties and inspiring youth. As NBA star LeBron James notes, "For me it's all about being able to inspire the youth, you know the kids that look up to me for inspiration... I can do that and inspire people not only here in America but all over the world is very humbling" (Cortsen 2017). The combination of economic and social contributions underscores the multifaceted influence of sports in contemporary society. At a broad level, sports offer numerous opportunities for management research on their role as a vehicle for cultural initiatives, educational campaigns, and community engagement. This cross-disciplinary research has the potential to offer valuable insights into the intersection of business strategy, social impact, and stakeholder engagement in the context of sports.

The sports industry increasingly intersects with broader societal, environmental, and geopolitical issues, positioning it as a critical site for both impact and inquiry. Sports have become a prominent platform for activism, with scholars such as Rheinhardt et al. (2023a) and Rheinhardt et al. (2023b) examining the motivations for athlete-led activism and its career implications. Simultaneously, sustainability and ethical investment have emerged as key concerns, as highlighted by Uecker-Mercado and Walker (2012) in the context of sporting infrastructure and by Naess (2019) in relation to financial practices within the industry.

While stadium construction has traditionally relied on a combination of private investment and public funding, the emergence of crowdfunding platforms has introduced a new avenue for financing. Increasingly, sports teams are leveraging these platforms to raise capital directly from fans and communities (O'Mara

2023). Future research could explore the implications of this shift, particularly for less mainstream sports, where conventional funding sources may be limited. Management theories such as the resource mobilization theory can shed light on how these teams mobilize financial and social resources through decentralized networks. This research may shed light on how crowdfunding influences fan engagement, financial sustainability, and the democratization of sports infrastructure development.

Geopolitical developments increasingly influence sports. Araullo (2024) highlights risks for companies in the sports industry resulting from geopolitical issues. The invasion of Ukraine by Russia exposed the vulnerability of the sports industry to geopolitical issues. The financial fallout from the invasion includes UEFA's cancellation of its sponsorship deal with Gazprom and the relocation of the 2022 Champions League final. Premier League clubs, including Manchester United, ended contracts with Russian sponsors, and Chelsea FC was required to change ownership. Another response was FIFA's emergency transfer window. More generally, the greater involvement of Middle Eastern countries in hosting major events is introducing new security threats such as conflict, terrorism, and domestic unrest. These developments underscore the need for further research on how geopolitical volatility shapes service quality in the global sports industry.

While the benefits of emerging virtual technologies and artificial intelligence in the sports industry are well-documented, these advancements also raise significant ethical and operational concerns. An important one is data privacy. As teams, leagues, and technology providers increasingly collect and analyze vast amounts of biometric, behavioral, and personal data, important questions arise: Who safeguards this data? How is informed consent obtained and managed from athletes and fans? Future research is needed to explore governance mechanisms, regulatory frameworks, and best practices that can ensure ethical and secure use of virtual and AI technologies in sports contexts.

Acknowledgments

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E-Companion for The Business of Sports: An Operations Perspective

EC.1   Additional Figures

Figure EC.1   Yearly Trend of Sports Articles Related to Operations Management in FT50 Journals
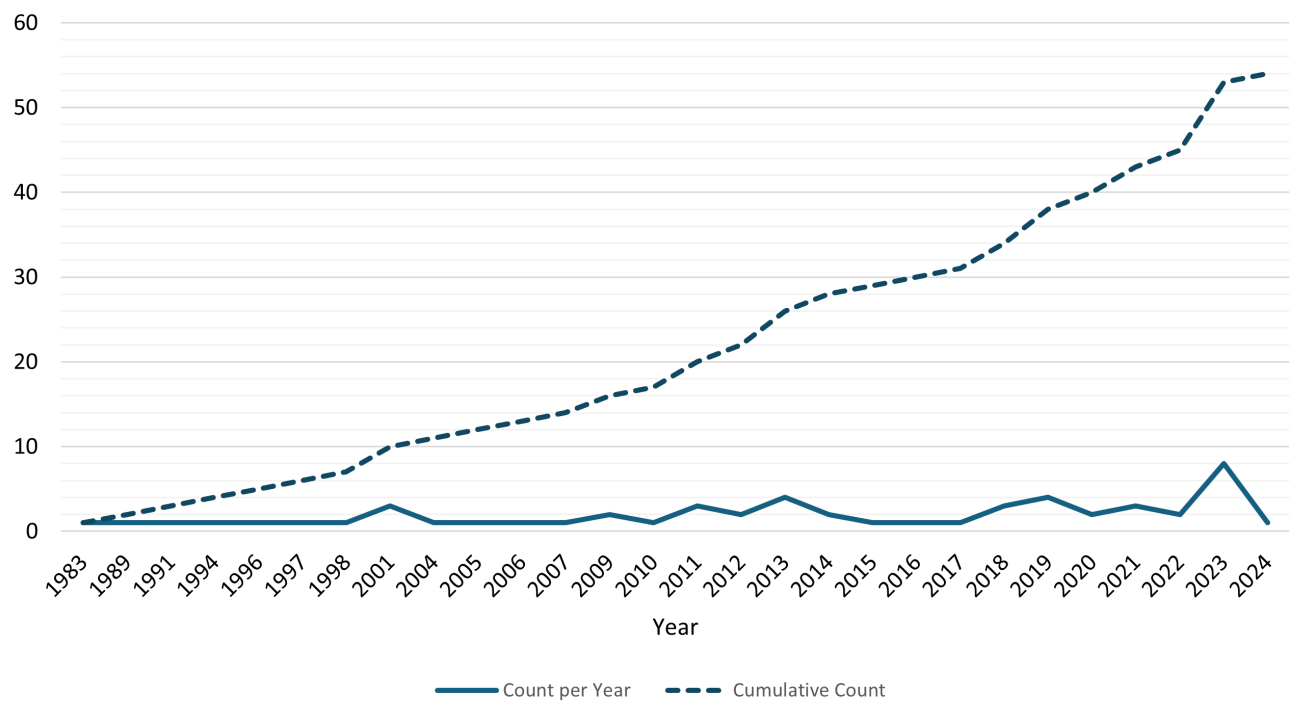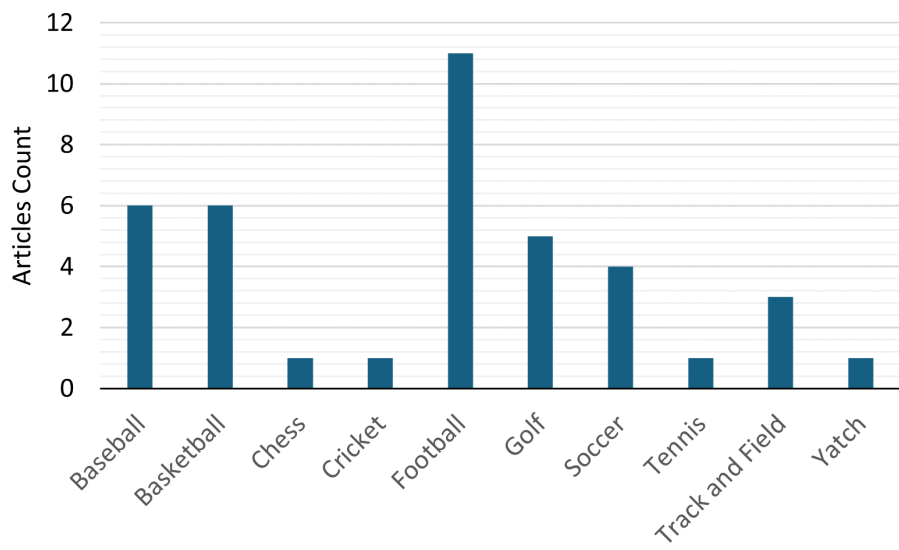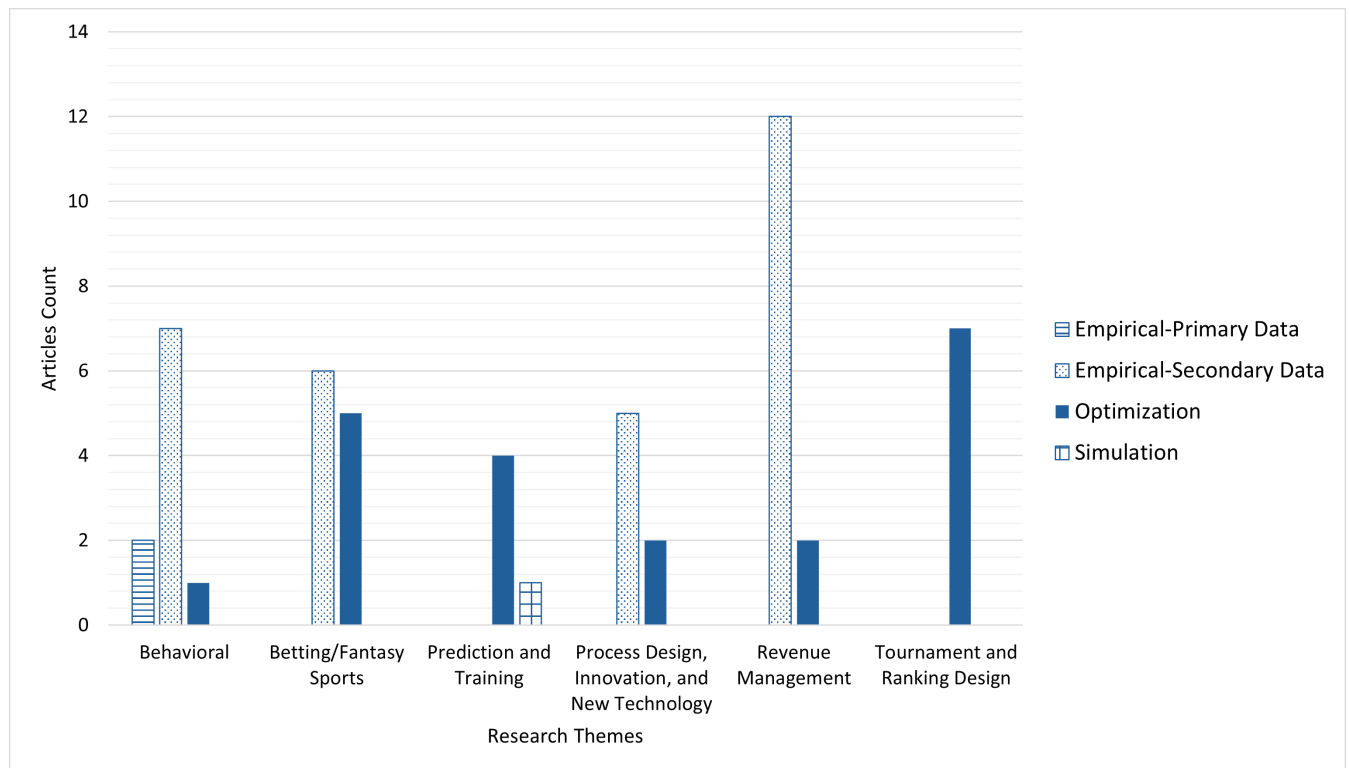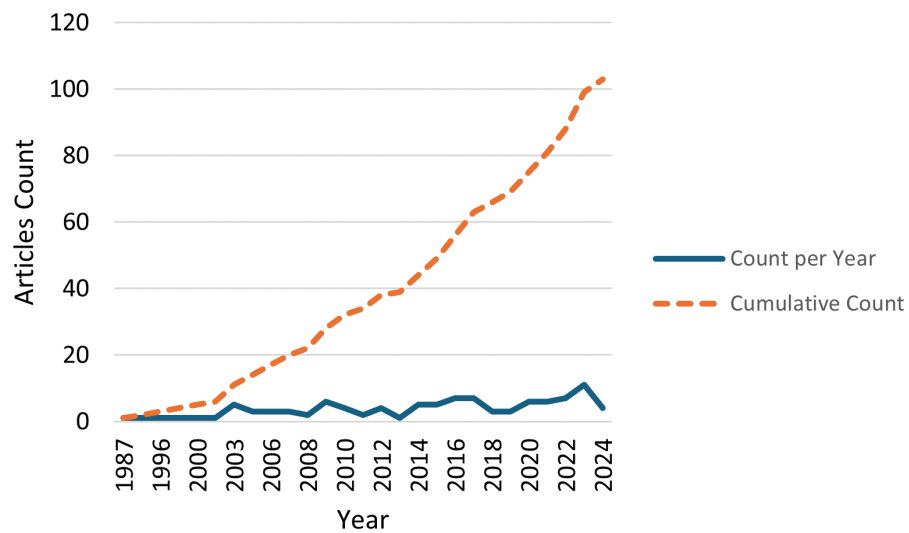

Figure EC.2   Breakdown by Sport

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Figure EC.3   Methodologies Used Across Key Sports Research Domains

Figure EC.4   Yearly Trend of Sports Articles Related to Operations Management in EJOR

EC.2   Review Research in FT50 Journals

EC.2.1   Behavioral

Research in this theme examines the impact of psychological and behavioral factors on decision-making and individual and team performance. Biases like the "hot hand" phenomenon, where athletes are perceived to perform better during a winning streak, are studied. Green and Zwiebel (2018) show the existence of this effect in baseball, contrasting with basketball, where defensive adjustments limit its occurrence. Similarly, Ritzwoller and Romano (2022) find that shooting streaks in basketball may not be entirely random, suggesting that the "hot hand" might be real in specific contexts. Another central theme is how psychological factors influence motivation and performance. Berger and Pope (2011) and Klein et al. (2023) investigate whether being slightly behind can motivate teams to perform better. While Berger and Pope (2011) find that being behind increases the likelihood of success in basketball, Klein et al. (2023) extend this to other sports, with mixed results. Additionally, studies like Kocher et al. (2012) address the first-mover advantage in penalty kicks, while others, such as Brown (2011) and Cohen-Zada et al. (2024), highlight the role of peer effects in enhancing or hindering team performance. The theme also extends to health-related decision-making, with Garcia et al. (2023) emphasizing the strategic behavior of athletes in reporting symptoms post-concussion and the importance of improving return-to-play decisions. Overall, this body of research primarily focuses on decision-making within the context of sports and competition, rather than decisions related to the business aspects of sports.

EC.2.2   Revenue management

Revenue management is an important domain within OM research that focuses on maximizing revenue from finite resources. Prior OM research within this domain has focused on pricing strategies, overbooking strategies, and demand management. Within the sports domain, this theme of research has received significant attention in top business school journals (i.e., FT50 journals). Prior studies primarily focus on issues related to revenue generation from tickets, endorsements, and media. Below, we discuss relevant research in this theme.

Revenue management from ticket sales: Ticket sales remain the primary source of game day revenue for sports organizations (DeGaris 2015). The landscape of ticket pricing strategies has evolved significantly, with sports organizations employing a range of approaches, including fixed pricing, variable pricing, and dynamic pricing.

In the fixed pricing model, also known as the tiered pricing model, ticket prices vary based on seat location but remain constant for all games throughout the season. This approach involves setting ticket prices at the beginning of the season for all home games. In the late 1990s, numerous teams transitioned to a variable pricing strategy. Variable pricing introduces flexibility by allowing ticket prices to vary across games and

seat locations. The key notion of the variable pricing model is that fans are willing to pay more for certain games, particularly against specific opponents such as traditional rivals, thereby generating more revenue for the teams. Teams employing variable pricing establish ticket prices in advance, typically at the start of the season, and often avoid any mid-season adjustments. Variable pricing is applied to both single tickets and season tickets. This implies that fans have the option to attend only a few games in a season, and the pricing of the season ticket now depends on the expected demand for each game.

Recent research has established the effectiveness of variable pricing strategies by demonstrating that teams experience higher ticket sales and revenue from tickets after adopting a variable pricing strategy. For instance, Courty and Davey (2020) show a 4.4% increase in revenue across MLB teams, and Arslan et al. (2023) find a 1.59% increase in game day ticket sales across NFL teams after the adoption of the variable pricing model. Furthermore, current studies continue to show that variable ticket pricing is effective in increasing the number of tickets sold and revenue generated in the primary market (Arslan et al. 2023). Other studies delve deeper into the development of a variable pricing framework by considering multiple sales platforms to determine the optimal ticket pricing strategy (Arslan et al. 2022). The shift to variable pricing not only showcases immediate benefits but also demonstrates a sustained effort by sports organizations to adapt to market dynamics. It emphasizes a proactive approach to maximize revenue and enhance the fan experience. This continuous evolution in ticket pricing strategies, supported by ongoing research, positions variable pricing as an important strategy for sports organizations to maximize their earnings from ticket sales.

Revenue management from sponsorship and endorsements: Apart from ticket sales, sponsorship and endorsements are another major source of income for sports organizations. Sponsorship deals are often worth several million dollars. For instance, Real Madrid generated an annual income of more than $200 million through sponsorship deals (Forbes 2016). Likewise, the NFL has sponsorship deals worth more than $1 billion (Young 2021). While sponsorship provides revenue to sports organizations, for sponsoring firms, it provides a platform to advertise and market their brands. Abril et al. (2018) find that the mere announcement of a sponsorship deal with a sports team had a positive effect on the market value of the sponsoring company. Furthermore, Hino and Takeda (2020) find that an announcement by a firm of a sponsorship deal with a sports team hurt a rival firm's market value. Endorsements by athletes are becoming an important medium to influence consumer purchase behavior and enhance brand value (Mallipeddi et al. 2022). Research in this area demonstrates the impact of athlete endorsements on both consumer behavior and purchases. Derdenger et al. (2018) reveals that athlete wins can enhance consumer awareness of the product endorsed by the athlete and drive sales, and Chung et al. (2013) show that endorsements not only induce consumers to switch brands, a business stealing effect, but also have a primary demand effect.

Revenue management from media: As mentioned in Section 1, the revenue generated from selling media rights is a major source of income for many teams. From the media networks' perspective, distributing

these revenues among the teams is often challenging and contentious. To address this issue, Bergantinos and Moreno-Ternero (2020) develop a decision model to distribute the revenues among teams. They first analyze the *equal-split rule*, which allocates the revenues from each game equally between the two participating teams. The second rule they consider is the *concede-and-divide rule* wherein each team keeps the revenues generated by its own fan base, and the remaining revenue (not directly linked to either fan base) is split equally between the teams. Their findings suggest that hybrid schemes, which combine elements of both the equal-split and concede-and-divide rules, produce results that closely align with the revenue distribution practices used by the Spanish National Professional Football League Association. Ad revenues are an important source of income for media networks. Unlike traditional programming with fixed ad slots, sports broadcasts have variable ad timing and duration, dictated by game breaks. This makes ad scheduling during live sports broadcasts a complex task. Popescu and Crama (2016) tackle this problem by proposing heuristics to optimize ad placement during live sports events. With the advent of online streaming platforms, future research is needed to explore ad placement strategies across different media platforms.

EC.2.3   Process design, innovation, and new technology

The OM literature has extensively explored the effects of process changes, innovation, and technological advancements across various business contexts. However, only a limited number of studies have examined the impact of these changes within the sports industry. A few studies have explored process flexibility in baseball (Chan and Fearing 2019), institutional change in cricket (Wright and Zammuto 2013), and service design in golf courses (Heim and Ketzenberg 2011), offering insights into the application of these concepts in sports. Concerning innovation in sports, Kim and Pennings (2009) examine how innovation in tennis racket design influences the adoption of new products by competitors. Munasinghe et al. (2001) analyze the effect of technological advancements on breaking new records in track and field. With the rise of AI, organizations are increasingly exploring ways to leverage these advancements to enhance efficiency and performance. Similarly, sports teams and athletes are incorporating AI to gain a competitive edge. In a recent study, Gaessler and Piezunka (2023) examine how AI-based training impacts player performance in chess.

In summary, while the OM literature has thoroughly examined process changes and innovations across various industries, the sports sector remains an emerging area of focus. As AI and other innovations continue to evolve, their integration into sports is likely to transform performance, strategy, and competition further.

EC.2.4   Prediction and training

As mentioned above, prior research has extensively explored and developed models aimed at optimizing training regimens and enhancing predictive capabilities in sports performance and outcomes. Our search of sports-related papers in the FT50 journals yields five papers on this theme. Papers in this theme explore

optimizing athletes' training schedule (e.g., Sierksma and Zwols 2009, Roels 2020) and game strategy and predicting yacht race outcomes through simulations that account for factors like wind conditions and race strategies (Philpott et al. 2004).

EC.2.5 Tournament design

Research in this stream addresses the challenges of scheduling and ranking in sports tournaments, with a primary focus on optimizing tournament schedules while considering multiple factors and constraints. We observe that this theme of research is widely studied in Operations Research related journals. The current research in this field can be classified into following sub-categories: (1) Tournament Scheduling and (2) Fairness and Rankings.

Tournament Scheduling: Research in this area focuses on scheduling of tournaments and games, often using optimization techniques, to minimize various conflicts and balance competition fairness. For example, Nemhauser and Trick (1998) and Henz (2001) address scheduling issues in basketball tournaments, accounting for factors such as home and away patterns, weekend games, key games scheduled in February, and opponent selection. Similarly, Boczoń and Wilson (2023) explore scheduling in soccer tournaments, emphasizing fairness by ensuring teams face similar distributions of potential opponents. Li et al. (2023) examine the scheduling problem in the context of video games.

Fairness and Rankings: Literature on this topic examines how tournament design influences competitive integrity and fairness in rankings. One of the themes on this topic is designing tournaments that ensure fair competitive balance (Avila-Cano et al. 2023). Similarly, another theme is designing tournaments to ensure that that ranking mechanisms do not inadvertently introduce incentives for behaviors that may compromise fairness. Csató (2022) show that the current point allocation system in European soccer leagues may encourage teams to manipulate outcomes to their advantage. Subsequently, they develop solutions to improve fairness. Matches are often disrupted by non-sporting factors, such as adverse weather conditions. While some sports, like soccer and American football, can continue in poor weather, others, such as cricket, must pause until conditions improve. In one-day cricket, each team is typically allotted 50 overs (each over comprising 6 balls, similar to pitches in baseball). When weather interruptions reduce the number of overs available to one or both teams, it can significantly impact their strategies and competitive balance. To address this, the Duckworth-Lewis method[1] is widely used in international cricket, adjusting the scoring targets to mitigate the impact of such interruptions. However, the method has faced substantial criticism. To enhance fairness, McHale and Asif (2013) propose a modified Duckworth-Lewis approach, which introduces adjustments aimed at equitable scoring to ensure that weather-related disruptions do not unfairly advantage or disadvantage either team. These studies highlight the critical role that tournament design plays

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[1] https://www.icc-cricket.com/about/cricket/rules-and-regulations/duckworth-lewis-stern

in aligning participants' incentives with the overarching goals of fair play and unbiased competition. This body of work is particularly valuable for tournament organizers aiming to minimize incentive misalignment and ensure fairness in competitive sports environments.

EC.2.6 Betting and fantasy sports

This theme is most widely studied in the FT50 journals. The current research can be classified into the following sub-categories: (1) Sports Betting, (2) Gambling Behavior, and (3) Fantasy sports.

Sports Betting: In this section, we review several aspects of sports betting and their effect on the business of sports. We first briefly discuss the legalization of sports betting in the U.S. Ramsey (2017) provides a more complete discussion. Historically, horse racing with on-track betting was the main legal avenue for sports betting. The 1919 Black Sox Scandal in baseball led to increased regulation of professional sports. During the mid-20th century, legislation moved against gambling because of its perceived connections to organized crime. In 1951, the Federal Government imposed a 10% tax on all sports bets, driving many sportsbooks out of business. The 1961 Wire Act prohibited the use of wire communications to place sports bets across state lines. The tax on sports betting was reduced to 2% in 1974, enabling Las Vegas to become the national center of sports betting through state-approved casinos. Negative publicity for sports betting arose from the gambling activities of Pete Rose which resulted in his 1989 ban from baseball. A significant negative development for sports betting occurred in 1992, with the passage of the Professional and Amateur Sports Protection Act (PASPA) which banned all government agencies from legalizing sports betting. These prohibitions were strengthened by the Unlawful Internet Gambling Enforcement Act (2006), which made it illegal to accept any gambling funds by Internet, and required banks to monitor and report such activity. However, a dramatic reversal occurred in May 2018 with the U.S. Supreme Court's decision in *Murphy vs. NCAA* which struck down PASPA as unconstitutional, based on 10th Amendment grounds that limit the federal government's power to regulate the States.

Since May 2018, the question of legalization of sports betting has belonged to the States, and 34 States and the District of Columbia have legalized it. Five of these States have not reported financial statistics for sports betting as of May 2023. The others have reported $222.7 billion in bets, with profits to sportsbook operators of $17.7 billion and taxes raised of $3.1 billion. As more States allow sports betting, and as more bettors become involved, the growth of sports betting is accelerating. In early 2023, monthly activity is averaging $10.2 billion in bets, $940 million in operators' profits, and $170 million in taxes generated even before the annual tax-reporting cycle (Ramsey 2013). With some of the largest potential markets still not legalized in California, Florida, and Texas, rapid further growth is likely. Globally, the annual sports betting market is expected to grow from $83.7 billion in 2022 to $182.1 billion in 2030, a CAGR of 10.3%.

The interest of financial research has been mostly in examining the efficiency of betting markets (e.g., Dare and MacDonald 1996, Gray and Gray 1997). Most studies, particularly in the context of the NFL,

generally suggest that the market operates with a level of efficiency, with limited evidence of significant inefficiencies. On the other hand, researchers in OM have focused on developing optimization models to optimize betting portfolios and enhance betting strategies (e.g., **?**Birge et al. 2021, **?**).

Gambling Behavior: A criticism that is often made of sports betting is that it is addictive. Gambling in general activates a reward system in the brain that is similar to that found in substance abuse addictions. However, Meyersohn (2023) identifies reasons why sports betting is even more addictive than gambling in general. The first reason is the bettor's overestimation of their expertise due to their interest in the sport, which promotes a false illusion of control. Second, in-game betting reduces the delay between risk and reward, which adds excitement. The ease and speed of transactions with online betting sites is a further incentive to participate. Sportsbooks are adept at marketing their services, for example through large universities, despite the legal gambling age of 21. Television advertising often features appealing sports celebrities who promote the partly false idea that picking winners is a matter of skill rather than luck. Finally, some types of sports bets are relatively complex - e.g., prop bets, parlays, and teaser bets - which makes it difficult for bettors to evaluate the odds being offered accurately. Gunn (2023) reports dramatic increases in calls to gambling hotlines in the first year after sports betting legalization: in Connecticut 91%, in Massachusetts 276%, in Virginia 387%.

In response, recent research has focused on developing tools to mitigate the addictive nature of these platforms. For instance, Hou et al. (2019) investigate the effectiveness of disruptive technological features designed to help users manage and control their gambling habits. They find that while these features are generally effective, they have limited impact on regular gamblers and those primarily involved in sports betting, compared to users of casino-style games. Similarly, Ma et al. (2014) explore online gambling behaviors and find that recent losses tend to decrease gambling activity, while recent gains encourage continued participation and regular use strengthens habitual gambling routines. Together, these studies highlight the relationship between user behavior, technological interventions, and the effectiveness of regulatory features in mitigating addiction to gambling.

Fantasy Sports: Fantasy sports are online games where players select and manage virtual teams composed of actual professional athletes. Players compete against each other's fantasy teams over the course of a season. At the end of the season, the players with the highest point totals win money from others. The global fantasy sports market in 2021 was $24 billion, and it is estimated to reach $78.5 billion at a CAGR of 14% by 2030 (Straits Research 2022). Among the drivers of this expansion are rapidly developing digital infrastructure especially in India and China, steep reductions in data pricing, and increasing data consumption which for example is estimated to triple in India by 2025. In addition, companies offering fantasy sports have invested heavily into this expanding market, resulting in better product offerings and a more satisfying customer experience. Contributing to these have been the use of fast and user-friendly interfaces, secure payment systems, and data management apps. However, there are issues with regulation, based in part on whether

fantasy sports is a game of skill which is typically legal, or a game of chance which is subject to state or local gambling restrictions. Several U.S. states have banned fantasy sports based on the latter definition. In fantasy sports, portfolio optimization is crucial for maximizing returns. Haugh and Singal (2021) develop a method to build strong fantasy teams by considering how other players are choosing their teams. With the growing popularity of fantasy sports, there is an opportunity to integrate machine learning with optimization methods, which could lead to more effective solutions for team selection strategies and payout optimization, offering new opportunities for innovation in this growing industry.

EC.3 Review of Research in EJOR and Sports Journals

In this section, we review articles published in EJOR and sports journals. In the subsequent sections (i.e., Sections EC.3 and EC.4), we provide a list of papers published in EJOR and sports journals respectively.

EC.3.1 Attendance/Viewership/Engagement

Previous research in this area primarily investigates the determinants of spectator demand, focusing on both stadium attendance and media-based viewership. Studies have examined how factors such as team performance (DeSchriver and Jensen 2002), competitive balance (Hogan et al. 2017), game significance, star player presence (DeSchriver 2007), socioeconomic factors (Lera-López et al. 2012), game day scheduling (Ermakov and Krumer 2023), and pricing strategies (Zygmont and Leadley 2005) affect live attendance. A parallel stream of literature explores the determinants of sports viewership, emphasizing how variables like match competitiveness (Brown and Salaga 2018), broadcast timing (Tainsky et al. 2013), and star power (Wills et al. 2022) influence fan engagement through media. Notably, the effect of outcome uncertainty on viewership remains inconclusive. For example, Brown and Salaga (2018) find no significant impact of uncertainty on NCAA football viewership, although closer-than-expected outcomes increase viewer interest. Similarly, Wills et al. (2022) report no significant relationship in the UEFA Champions League context. In contrast, Tainsky et al. (2013) find that uncertainty boosts viewership in UFC events. Reams and Shapiro (2017) further examine how several of these factors affect pay-per-view pricing. Overall, the literature spans diverse contexts—from European rugby to American college sports—highlighting a broad, international interest in understanding the economics of fan behavior and sports consumption.

EC.3.2 Betting and Fantasy Sports

Research in this area explores the behavioral aspects of fantasy sports and sports betting. Previous studies investigate why individuals participate in fantasy sports and how psychological factors such as confidence, perceived control, and identity affect participation (Lee et al. 2013). Ruihley and Hardin (2011) emphasize the role of competition and camaraderie as key motivators for participation. Gender is also shown as an important factor, with Dwyer et al. (2018) showing that women often engage in fantasy football to challenge traditional gender norms and demonstrate competence in male-dominated environments. While men and women share common motives such as competition and enjoyment, women are more strongly motivated by social connection and interaction. Yuksel et al. (2017) highlights the psychological tension that arises when participants support both a fantasy team and a real-life favorite team. The authors explore how this conflict leads to coping strategies, such as selecting players impartially or shifting support depending on the situation. This illustrates the emotional complexity of fantasy sports as a co-created form of sport consumption. In the context of sports betting, Nosal and Lopez-Gonzalez (2021) examine the effects of external shocks, such as the COVID-19 pandemic, on betting behavior. They find that many regular bettors reduced

or stopped betting and did not substitute it with other forms of gambling, suggesting that the availability of live sports is crucial to sustaining betting habits.

EC.3.3 Governance and Regulatory Issues in Sports

Research in sport governance examines issues related to resource allocation, athlete rights, gender equity, institutional integrity, and public investment. In intercollegiate athletics, resource distribution across different sports is complex because revenue generated from a few sports far exceed other sports. The prior literature explores various mechanisms for allocating these resources, including need-based fairness, equal treatment across sports, and revenue-generation priorities (Patrick et al. 2008). Until recently, debates surrounding amateurism and the appropriateness of generating revenue without compensating student-athletes were intensifying, prompting research into athletes' perceptions of compensation and amateurism (Kaburakis et al. 2012). However, the direction of this debate has shifted significantly following the NCAA's recent adoption of the Name, Image, and Likeness (NIL) policy, which allows athletes to profit directly from their personal brands. Concurrently, the pursuit of gender equity under Title IX continues to be influenced by these financial dynamics, as revenue from sports like football often impacts institutional compliance with gender equity mandates, specifically regarding proportional scholarship allocations and participation opportunities for women in NCAA Division I-A programs (Agthe and Billings 2000). In the domain of sport infrastructure and event hosting, governance challenges frequently emerge during negotiations over public subsidies. When municipalities bid to host major sporting events, they often offer significant financial incentives to professional teams, potentially incurring substantial costs without clear public benefits. Prior research has investigated how these subsidies can be strategically designed to mitigate financial risks and maximize community returns (Rosentraub and Swindell 2002). Sport integrity is also an important governance priority, with match-fixing identified as a major organizational risk even at the grassroots level. Previous research emphasizes the need for protective capacities within sport organizations to prevent manipulation and preserve fairness in competition (Nowy and Breuer 2017).

EC.3.4 Revenue Management

Within the revenue management literature in sports management, prior research primarily examines three interconnected areas: pricing strategies, demand management, revenue sharing, and spillover effects.

The literature on pricing strategies in sports management primarily highlights pricing models and secondary market dynamics. Studies examining ticket pricing consistently highlight the benefits and key influencing factors of dynamic and variable pricing models. Specifically, the adoption of variable pricing has been associated with increased revenue for Major League Baseball teams (Rascher et al. 2007). Further, empirical studies have identified various determinants that influence ticket pricing decisions (Quansah et al.

2024). Studies on dynamic pricing models reveal a general upward trend in ticket prices over time, emphasizing the role of fluctuating consumer demand and market conditions (Kemper and Breuer 2016). Additionally, Wassell Jr and Carbaugh (2022) discuss the evolution of dynamic pricing, Research on secondary market dynamics explores how the expansion of secondary ticket markets influences firms' pricing strategies and market behaviors (Shapiro and Drayer 2012). The rapid growth of these markets has raised concerns regarding legitimacy and public perception, motivating researchers to investigate strategies used by secondary market participants to establish credibility and gain consumer trust (Drayer and Martin 2010). Further research quantifies the economic impact of secondary markets, highlighting the substantial consumer surplus generated by resellers. Specifically, secondary markets can create demand equivalent to an additional 20,000 seats per game. Since teams cannot readily increase seating capacity—partly due to regulatory constraints such as the NFL's blackout rule—secondary market resellers capture approximately $260,000 in consumer surplus per game, underscoring the economic significance of these market participants Drayer et al. (2012). Research on season ticket holders (STHs), who represent a critical revenue stream for sports teams, examines factors influencing their retention and satisfaction. McDonald (2010) suggests that focusing on intangible benefits—such as fostering a stronger sense of involvement, building a sense of community, and enhancing patron value—can effectively reduce churn among STHs. Additionally, factors including team performance, stadium features, and targeted media advertising have also been shown to significantly influence renewal decisions (Brown et al. 2009). While overall satisfaction among season ticket holders tends to be driven by similar elements across genders, the relative importance of these elements differs notably. For example, female STHs place greater emphasis on customer service quality and the facilities at home venues, whereas male STHs report higher satisfaction from feeling personally involved with the team and its management (McDonald et al. 2018). Collectively, this literature underscores factors affecting STH satisfaction and the necessity of tailoring retention strategies to different consumer segments. Additional literature extends this discussion by highlighting how individual athletes can independently drive ticket demand, with certain players positively influencing attendance beyond their on-court performance ratings alone (Chmait et al. 2020). Furthermore, previous research has explored revenue-sharing mechanisms and related financial issues commonly encountered by sports teams, highlighting their impact on competitive balance, league stability, and financial sustainability (Wenz 2012, Rascher et al. 2011, Kesenne 2006). Finally, research into the spillover effects of major sporting events, such as the FIFA World Cup, shows significant economic impacts on local communities, emphasizing the need for effective financing strategies to maximize benefits (Bohlmann and Van Heerden 2008). Studies examining hotel demand related to sporting events also reveal considerable variability based on team and opponent quality, suggesting opportunities for strategic scheduling and targeted pricing strategies (DeSchriver et al. 2021). Together, these findings underscore the complex interplay of individual and structural factors shaping consumer demand, hospitality revenue, and overall financial performance in sports.

EC.3.5 Process Design, Innovation, and New Technology

Technology, innovation, and process improvement have received attention in the sports management literature, as organizations increasingly seek to enhance decision-making and improve operational efficiency through new technologies. Prior research has examined how technology and process changes help team owners in optimizing operations, improving profitability (Hayduk 2022), and have expanded recruitment (Sam et al. 2018). The adoption of emerging technologies—ranging from broadcasting systems to wearables and communication technologies has further affected how decisions are made, how teams learn, and how outcomes unfold (Ko et al. 2011, Larson and Maxcy 2014, Olaniyan et al. 2024).

In parallel, studies have investigated the patterns of adoption and diffusion of these technologies across different institutional settings (Nite and Washington 2017, Pizzo et al. 2020, Muller and Bevan-Dye 2023, Williams et al. 2021). Other work has explored the role of digital transformation and cultural drivers that shape innovation within sport organizations (Harris et al. 2021, Hoff et al. 2024, Merten et al. 2024). Finally, typologies proposed by Winand et al. (2013), Hoeber et al. (2015), Corthouts et al. (2023) classify innovations based on their form, function, and organizational drivers, providing valuable frameworks for evaluating and guiding innovation efforts in an increasingly digital sports landscape.

EC.3.6 Prediction and Training

A growing body of research in OR focuses on evaluating and improving decision-making in sports settings. These studies span multiple domains—including football, tennis, soccer, baseball, golf, and Olympic competitions—and collectively demonstrate the applicability of a broad set of methodological tools such as statistical, Data Envelopment Analysis (DEA), optimization modeling, and network-based analytics. One stream of literature has focused on predicting performance at both the individual and team levels. For instance, Craig and Winchester (2021) develop a predictive model to estimate the professional potential of college football quarterbacks, while McHale and Relton (2018) leverage network analysis and pass difficulty metrics to identify pivotal players in soccer teams. In the context of baseball, Özlü and Sokol (2016) formulate an integer programming model to optimize scouting assignments, highlighting the value of analytics in improving talent identification processes. Relatedly, Sueyoshi et al. (1999) and Fried et al. (2004) propose benchmark-based approaches for evaluating individual performance in baseball and golf, whereas Li et al. (2015) employ a two-stage DEA framework to assess Olympic team efficiency across nations.

Research on prediction and training now explores real-time, in-play forecasting models that dynamically update outcome predictions as games progress. These models not only support more responsive in-game decision-making but also contribute to the broader theoretical literature on prediction under uncertainty. Song and Shi (2020), for instance, propose a statistical framework that forecasts final game outcomes conditional on the current score and elapsed time. In soccer, Villa and Lozano (2016) develop a model for

predicting scoring efficiency using contextual match data, enabling near real-time performance evaluation. Similarly, Klaassen and Magnus (2003) focus on point-by-point prediction in tennis, while Collingwood et al. (2023) offer a simulation-based model to estimate the probability of winning a frame from any game state. In related work, Bruinshoofd and Ter Weel (2003) and de Dios Tena and Forrest (2007) examine performance prediction at the managerial level. Together, these studies explore evaluating static performance metrics to modeling dynamic, real-time outcomes.

EC.3.7 Tournament Design

The literature, primarily articles published in EJOR, in this stream focuses on scheduling of tournaments, determining rankings, and game rules.

Studies focusing on scheduling strategies utilize different OR techniques, such as integer programming, constraint programming, graph theory, and heuristic algorithms, to optimize timetables, enhance competitiveness, and address practical scheduling constraints in tournament formats ranging from round-robin leagues to international competitions (e.g., Yi et al. 2020, van Doornmalen et al. 2023). A few recent studies in this area are discussed below. Urban and Russell (2003) examine the complexities of organizing competitions across multiple venues, a common logistical constraint in professional and amateur sports. Addressing concerns around competitive fairness, Chater et al. (2021) propose scheduling strategies aimed at reducing incentives for match-fixing, particularly in scenarios where teams that have already qualified may manipulate outcomes based on potential future opponents. From a methodological perspective, van Doornmalen et al. (2023) explore integer programming formulations for round-robin tournament scheduling, concluding that the matching formulation provides a stronger linear relaxation while remaining computationally tractable. As the complexity of sports scheduling continues to grow, there is increasing interest in benchmarking and improving algorithmic approaches to timetabling. In their article, Van Bulck and Goossens (2023) introduce the fifth International Timetabling Competition, a global initiative designed to foster innovation in automated sports scheduling. The competition offers a platform for evaluating and comparing diverse algorithms across realistic problem settings. Building on this, Van Bulck et al. (2024) provide a comprehensive analysis of sports timetabling problem types and assess the performance of eight leading algorithms. Their evaluation offers practical guidance on algorithm selection based on specific scheduling needs, contributing to both methodological rigor and real-world applicability in sports operations.

The second stream of literature focuses on the development of models for rating players and teams, constructing fair and transparent ranking systems, and optimizing tournament structures across a variety of sports contexts, including football, tennis, snooker, cycling, and hockey. Bozóki et al. (2016) introduce a ranking method based on incomplete pairwise comparison matrices to evaluate top tennis players, while Baker and McHale (2017) develop a predictive model to identify the greatest women's tennis player using historical performance data. In international soccer, time-varying and performance-based models have been

proposed to improve team rating systems (Baker and McHale 2018, Kharrat et al. 2020). Similar methodological advancements have been applied to domain-specific settings, including snooker (Collingwood et al. 2022), multi-stage cycling tournaments (Ausloos 2024), and playoff qualification in the NHL (Russell and van Beek 2012). In large-scale tournament settings, Zhong et al. (2025) propose a knockout tournament simulation framework that supports efficient parallel decision-making under uncertainty. Collectively, these studies contribute to the literature by demonstrating how quantitative models can improve fairness, predictive performance, and strategic decision-making in competitive environments.

While ranking and tournament scheduling research focuses on the design of competition formats, optimization of match assignments, and the development of fair and effective rating systems (e.g., who plays whom, when, and how teams/players are ranked), a few papers examine within-match dynamics and rule-based interventions (e.g., McHale and Asif 2013, Geenens 2014, Silva et al. 2015), analyzing how rules and gameplay mechanisms influence scoring behavior, strategic decisions, or fairness during a game or match. McHale and Asif (2013) propose a method to adjust rain-interrupted cricket matches. Silva et al. (2015) study the impact of new "powerplay" rules on scoring dynamics in one-day cricket matches. Hall and Liu (2024) discuss the potential for opponent choice to be used in single elimination sports tournaments.

EC.4 List of Papers in EJOR

Table EC.1 Summary of Behavioral Papers in EJOR

Title	Year	Method
Decision taking under pressure: Evidence on football manager dismissals in Argentina and their consequences	2012	Empirical

Table EC.2 Summary of Sports Betting/Fantasy Sports Papers in EJOR

Title	Year	Method
Misunderstanding of the binomial distribution, market inefficiency, and learning behavior: Evidence from an exotic sports betting market	2015	Statistical Models
Do 'big losses' in judgmental adjustments to statistical forecasts affect experts' behaviour?	2016	Empirical
The wisdom of amateur crowds: Evidence from an online community of sports tipsters	2019	Optimization
Optimal bookmaking	2021	Optimization
Bettors' reaction to match dynamics: Evidence from in-game betting	2023	Statistical Models

Table EC.3: Summary of Prediction/Training Papers in EJOR

Title	Year	Method
Yacht velocity prediction using mathematical programming	1993	Optimization
Benchmark approach for baseball evaluation	1999	Simulation
Forecasting the winner of a tennis match	2003	Statistical Models
A simulation model for football championships	2003	Simulation
Manager to go? Performance dips reconsidered with evidence from Dutch football	2003	Empirical
Evaluating the performance of professional golfers on the PGA, LPGA and SPGA tours	2004	Empirical
Within-season dismissal of football coaches: Statistical analysis of causes and consequences	2007	Empirical
Dynamic programming and board games: A survey	2007	Survey
Achievement and benchmarking of countries at the Summer Olympics using cross efficiency evaluation method	2009	DEA
Equitable birthdate categorization systems for organized minor sports competition	2009	Statistical Models
Optimizing strategic behaviour in a dynamic setting in professional team sports	2010	Optimization
Analysing head coach dismissals in the German "Bundesliga" with a mixed logit approach	2010	Empirical
A dynamic paired comparisons model: Who is the greatest tennis player?	2014	Statistical Models

Performance evaluation of participating nations at the 2012 London Summer Olympics by a two-stage data envelopment analysis	2015	Simulation
An optimization approach to designing a baseball scout network	2016	Optimization
Assessing the scoring efficiency of a football match	2016	Optimization
Search for optimal sailing policy	2017	Optimization
Crowd performance in prediction of the World Cup 2014	2017	Empirical
Identifying key players in soccer teams using network analysis and pass difficulty	2018	Statistical Models
Evaluating an alternative draft pick allocation policy to reduce 'tanking' in the Australian Football League	2018	Optimization
A gamma process based in-play prediction model for National Basketball Association games	2020	Statistical Models
Predicting the national football league potential of college quarterbacks	2021	Empirical
Performance benchmarking of achievements in the Olympics: An application of Data Envelopment Analysis with restricted multipliers	2021	Simulation
A heuristic approach for lactate threshold estimation for training decision-making: An accessible and easy to use solution for recreational runners	2021	Optimization
Expert performance and crowd wisdom: Evidence from English Premier League predictions	2021	Empirical
Weighted Elo rating for tennis match predictions	2022	Statistical Models
Simulating the progression of a professional snooker frame	2023	Simulation
Optimizing pit stop strategies in Formula 1 with dynamic programming and game theory	2024	Optimization

Table EC.4 Summary of Process Design, Innovation, and New Technology Papers in EJOR

Title	Year	Method
Organizational capability, efficiency, and effectiveness in Major League Baseball: 1901-2002	2009	Simulation

Table EC.5   Summary of Revenue Management Papers in EJOR

Title	Year	Method
Implications of personalization offers on demand and supply network design: A case from the golf club industry	2006	Case Study
Beyond crowd judgments: Data-driven estimation of market value in association football	2017	Empirical
Let's meet as usual: Do games played on non-frequent days differ? Evidence from top European soccer leagues	2020	Empirical
Optimal selection of touristic packages based on user preferences during sports mega-events	2022	Optimization
Armchair fans: Modelling audience size for televised football matches	2022	Empirical
Monotonicity in sharing the revenues from broadcasting sports leagues	2022	Statistical Models
Estimating transfer fees of professional footballers using advanced performance metrics and machine learning	2023	Empirical

Table EC.6: Summary of Tournament Design Papers in EJOR

Title	Year	Method
A new points system for soccer leagues: Have expectations been realised?	1987	Empirical
Optimal realignments of the teams in the National Football League	1996	Optimization
Comparing the efficacy of ranking methods for multiple round-robin tournaments	2000	Statistical Models
Quality function deployment for the good of soccer	2002	Statistical Models
Scheduling sports competitions on multiple venues	2003	Optimization
Persistence in sequences of football match results: A Monte Carlo analysis	2003	Simulation
Memetic algorithm timetabling for non-commercial sport leagues	2004	Optimization
Global constraints for round robin tournament scheduling	2004	Optimization
A simulated annealing and hill-climbing algorithm for the traveling tournament problem	2006	Optimization
Scheduling sports competitions at multiple venues-Revisited	2006	Optimization
Heuristics for the mirrored traveling tournament problem	2007	Optimization
Round robin scheduling - a survey	2008	Survey
Scheduling a triple round robin tournament for the best Danish soccer league	2008	Optimization
Combinatorial properties of strength groups in round robin tournaments	2009	Optimization
A numerical study of designs for sporting contests	2009	Empirical
A branching scheme for finding cost-minimal round robin tournaments	2009	Optimization
The selection efficiency of tournaments	2010	Statistical Models
Scheduling non-professional table-tennis leagues	2010	Optimization
A multi-round generalization of the traveling tournament problem and its application to Japanese baseball	2011	Optimization
A note on symmetry reduction for circular traveling tournament problems	2011	Optimization
Mean value and volume-based sensitivity analysis for Olympic rankings	2012	Optimization
A hybrid constraint programming and enumeration approach for solving NHL playoff qualification and elimination problems	2012	Optimization

Locally optimized crossover for the traveling umpire problem	2012	Optimization
A modified Duckworth-Lewis method for adjusting targets in interrupted limited overs cricket	2013	Statistical Models
On the decisiveness of a game in a tournament	2014	Statistical Models
Decomposition and local search based methods for the traveling umpire problem	2014	Optimization
OR analysis of sporting rules - A survey	2014	Survey
Improved bounds for the traveling umpire problem: A stronger formulation and a relax-and-fix heuristic	2014	Optimization
What is a good result in the first leg of a two-legged football match?	2015	Empirical
A study of the powerplay in one-day cricket	2015	Empirical
Two exact algorithms for the traveling umpire problem	2015	Optimization
An application of incomplete pairwise comparison matrices for ranking top tennis players	2016	Optimization
Edge coloring: A natural model for sports scheduling	2016	Optimization
The tournament scheduling problem with absences	2016	Optimization
Branch-and-bound with decomposition-based lower bounds for the Traveling Umpire Problem	2016	Optimization
Scheduling the South American Qualifiers to the 2018 FIFA World Cup by integer programming	2017	Optimization
When sports rules go awry	2017	Survey
An empirical Bayes model for time-varying paired comparisons ratings: Who is the greatest women's tennis player?	2017	Statistical Models
Scheduling double round-robin tournaments with divisional play using constraint programming	2017	Optimization
Time-varying ratings for international football teams	2018	Statistical Models
Scheduling Argentina's professional basketball leagues: A variation on the Travelling Tournament Problem	2019	Optimization
On outcome uncertainty and scoring rates in sport: The case of international rugby union	2019	Statistical Models
Proactive and reactive strategies for football league timetabling	2020	Empirical
Plus–minus player ratings for soccer	2020	Statistical Models
Fair elimination-type competitions	2020	Optimization
RobinX: A three-field classification and unified data format for round-robin sports timetabling	2020	Optimization
Fixing match-fixing: Optimal schedules to promote competitiveness	2021	Statistical Models
Quantifying incentive (in)compatibility: A case study from sports	2022	Case Study
Evaluating the effectiveness of different player rating systems in predicting the results of professional snooker matches	2022	Statistical Models
A greedy algorithm for the social golfer and the Oberwolfach problem	2022	Optimization
Integer programming models for round robin tournaments	2023	Optimization
How to avoid uncompetitive games? The importance of tie-breaking rules	2023	Statistical Models
The international timetabling competition on sports timetabling (ITC2021)	2023	Optimization
Measuring competitive balance in sports leagues that award bonus points, with an application to rugby union	2023	Statistical Models
A traditional Benders' approach to sports timetabling	2023	Optimization

Multi-league sports scheduling with different leagues sizes	2023	Optimization
A unified theory for bivariate scores in possessive ball-sports: The case of handball	2023	Statistical Models
Fewer teams, more games, larger attendance? Evidence from the structural change in basketball's EuroLeague	2023	Empirical
Hierarchy selection: New team ranking indicators for cyclist multi-stage races	2024	Statistical Models
Reference alternatives based knockout-tournament procedure for ranking and selection	2024	Statistical Models
Which algorithm to select in sports timetabling?	2024	Optimization

EC.5   List of Papers in Sports Journals

Table EC.7   Summary of Attendance/Viewership/Engagement Papers in Sports Journals

Title	Year	Journal	Methods
Determinants of spectator attendance at NCAA Division II football contests	2002	Journal of Sport Management	Empirical
When is the honeymoon over? Major league baseball attendance 1970-2000	2005	Journal of Sport Management	Empirical
Much Adieu about Freddy: Freddy Adu and attendance in major league soccer	2007	Journal of Sport Management	Empirical
Sports spectatorship in Spain: Attendance and consumption	2012	European Sport Management Quarterly	Empirical
Determinants of pay-per-view broadcast viewership in sports: The case of the ultimate fighting championship	2013	Journal of Sport Management	Empirical
Analysing match attendance in the European Rugby Cup: Does uncertainty of outcome matter in a multinational tournament?	2017	European Sport Management Quarterly	Empirical
Who's the main attraction? Star power as a determinant of Ultimate Fighting Championship pay-per-view demand	2017	European Sport Management Quarterly	Empirical
NCAA football television viewership: Product quality and consumer preference relative to market expectations	2018	Sport Management Review	Empirical
Betting market outcomes and NBA television viewership	2020	Journal of Sport Management	Empirical
Understanding season ticket holder attendance decisions	2021	Journal of Sport Management	Empirical
The impact of live broadcasting on stadium attendance reconsidered: Some evidence from 3rd division football in Germany	2022	European Sport Management Quarterly	Empirical
Uncertainty of outcome, team quality or star players? What drives TV audience demand for UEFA Champions League football?	2022	European Sport Management Quarterly	Empirical
Saturday in the stadium: On higher attendance on Saturdays in Norwegian Eliteserien soccer league	2023	European Sport Management Quarterly	Empirical
Opponent choice in tournaments: Winning and shirking	2024	Journal of Quantitative Analysis in Sports	Statistical / Empirical

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Table EC.8   Summary of Betting and Fantasy Papers in Sports Journals

Title	Year	Journal	Methods
How confident are you to win your fantasy league: Exploring the antecedents and consequences of winning expectancy	2010	Journal of Sport Management	Empirical
Beyond touchdowns, homeruns, and three-pointers: An examination of fantasy sport participation motivation	2011	International Journal of Sport Management and Marketing	Qualitative
Understanding why people play fantasy sport: Development of the Fantasy Sport Motivation Inventory (FanSMI)	2013	European Sport Management Quarterly	Qualitative
The paradoxical relationship between fantasy football and NFL consumption: Conflict development and consumer coping mechanisms	2017	Sport Management Review	Qualitative
Challenge accepted: Why women play fantasy football	2018	Journal of Sport Management	Empirical
How did regular sports bettors behave during covid-19 lockdown? Evidence from Poland	2021	European Sport Management Quarterly	Empirical

Table EC.9   Summary of Governance and Regulatory Issues in Sports Papers in Sports Journals

Title	Year	Journal	Methods
Taxpayer Subsidies for Major Sporting Events	1998	Sport Management Review	Qualitative
The role of football profits in meeting title IX gender equity regulations and policy	2000	Journal of Sport Management	Qualitative
Negotiating games: Cities, sports, and the winner's curse	2002	Journal of Sport Management	Qualitative
Distributive justice in intercollegiate athletics: An examination of equality, revenue production, and need	2008	Journal of Sport Management	Qualitative
Is it still "in the game", or has amateurism left the building? NCAA student-athletes' perceptions of commercial activity and sports video games	2012	Journal of Sport Management	Qualitative
Institutions of higher commitment: A case study of de-escalation and American football's decisive role in intercollegiate athletics	2015	Sport Management Review	Qualitative
Match-fixing in European grassroots football	2017	European Sport Management Quarterly	Empirical
National sport organization governance design archetypes for the twenty-first century	2023	European Sport Management Quarterly	Qualitative

Table EC.10: Summary of Process Design, Innovation, and New Technology Papers in Sports Journals

Title	Year	Journal	Methods
Context receptivity: Innovation in an amateur sport organization	2000	Journal of Sport Management	Qualitative
Broadcasting technology and its influence on sport broadcaster inter-organisational relationship formation	2008	International Journal of Sport Management and Marketing	Qualitative
The impact of emerging technology in sport broadcasting on the preconditions for interorganizational relationship (IOR) formation in professional football	2010	Journal of Sport Management	Qualitative
Do spectators and competitors accept the use of scoring technology in Taekwondo competitions?	2011	International Journal of Sport Management and Marketing	Empirical
Determinants of service innovation: A typology of sports federations	2013	International Journal of Sport Management and Marketing	Empirical
Uncertainty of outcome and radio policy in professional road cycling	2014	Journal of Sport Management	Empirical
The nature of innovation in community sport organizations	2015	European Sport Management Quarterly	Qualitative
A social identity analysis of technological innovation in an action sport: judging elite half-pipe snowboarding	2016	European Sport Management Quarterly	Qualitative
The impact of coopetition-based open innovation on performance in nonprofit sports clubs	2016	European Sport Management Quarterly	Empirical
Collaborative self-study: Lessons from a study of wearable fitness technology and physical activity	2017	Sport Management Review	Qualitative
Innovations in Major League Baseball catalysing factors: When winning is not enough	2017	International Journal of Sport Management and Marketing	Qualitative
Institutional adaptation to technological innovation: Lessons from the NCAA's regulation of football television broadcasts (1938-1984)	2017	Journal of Sport Management	Empirical
The modernisation of umpire development: Netball New Zealand's reforms and impacts	2018	European Sport Management Quarterly	Qualitative
Antecedents and outcomes of social innovation: A global study of sport for development and peace organizations	2020	Sport Management Review	Qualitative
Innovation in national governing bodies of sport: investigating dynamic capabilities that drive growth	2021	European Sport Management Quarterly	Qualitative

NCAA e-sports 20XX: An analysis of radical innovation adoption through firm collaboration	2021	International Journal of Sport Management and Marketing	Qualitative
Sport experience design: wearable fitness technology in the health and fitness industry	2021	Journal of Sport Management	Qualitative
Are "tech-savvy" owners Better for Business? Evidence from Major League Baseball	2022	Journal of Sport Management	Empirical
You'll never want to watch alone: The effect of displaying in-stadium social atmospherics on media consumers' responses to new sport leagues across different types of media	2022	European Sport Management Quarterly	Empirical
Perceived service innovation in non-profit sports clubs: the antecedents and consequence	2022	European Sport Management Quarterly	Empirical
The impact of knowledge management on performance in nonprofit sports clubs: The mediating role of attitude toward innovation open innovation and innovativeness	2022	European Sport Management Quarterly	Qualitative
A three-dimensional model of innovation within Flemish non-profit sports organisations	2023	European Sport Management Quarterly	Qualitative
Analogous forecasting for predicting sport innovation diffusion: From business analytics to natural language processing	2023	Journal of Sport Management	Empirical
Enhancing on-pitch learning capabilities with data analytics and technologies in elite sports	2023	European Sport Management Quarterly	Qualitative
Generation Y consumers' wearable activity-tracker adoption intention: applying the theory of planned behaviour	2023	International Journal of Sport Management and Marketing	Qualitative
The legitimacy work of institutional disruption and maintenance: Examining the rivalry between LIV golf and the professional golf association	2024	European Sport Management Quarterly	Qualitative
Innovation drivers barriers and strategies of organizing committees for the Olympic games: An embedded single-case study approach	2024	European Sport Management Quarterly	Qualitative
Interactive mechanisms to improve service innovation among sports clubs: A consumer perspective	2024	Journal of Sport Management	Qualitative
Unlocking value: Exploring digital transformation's influence on knowledge management of national football associations	2024	European Sport Management Quarterly	Qualitative

Table EC.11: Summary of Revenue Management Papers in Sports Journals

Title	Year	Journal	Methods
Revenue sharing and agency problems in professional team sport: The case of the National Football League	1997	Journal of Sport Management	Qualitative
The demand for programs at a college football game: OLS and LMS estimates of optimal prices	2002	Journal of Sport Management	Empirical
Manipulating consumer price expectations for a 10K road race	2003	Journal of Sport Management	Empirical
Competitive balance in team sports and the impact of revenue sharing	2006	Journal of Sport Management	Analytical
Revenue generation in professional sport: A diagnostic analysis	2006	International Journal of Sport Management and Marketing	Empirical
Variable ticket pricing in Major League Baseball	2007	Journal of Sport Management	Empirical
Predicting the economic impact of the 2010 FIFA World Cup on South Africa	2008	International Journal of Sport Management and Marketing	Empirical
Free agent auctions and revenue sharing:A simple exposition	2009	Journal of Sport Management	Analytical
Membership retention in professional sports organisations	2009	International Journal of Sport Management and Marketing	Empirical
Prediction of ticket purchase in professional sport using data mining	2009	International Journal of Sport Management and Marketing	Empirical
Establishing legitimacy in the secondary ticket market: A case study of an NFL market	2010	Sport Management Review	Qualitative
Asymmetries in scheduling slots and game-day revenues: An example from the Australian Football League	2010	Sport Management Review	Empirical
The factors influencing churn rates among season ticket holders: An empirical analysis	2010	Journal of Sport Management	Empirical
Participation rates and gross revenue vs. promotion and exposure: Advertisement and multimedia coverage of 18 sports within NCAA Division I athletic department websites	2011	Sport Management Review	Empirical
Free ride, take it easy: An empirical analysis of adverse incentives caused by revenue sharing	2011	Journal of Sport Management	Empirical
Examining the effectiveness of anti-scalping laws in a United States market	2011	Sport Management Review	Qualitative
A proposal for incentive-compatible revenue sharing in major league baseball	2012	Journal of Sport Management	Empirical

Understanding the interactions among revenue categories using elasticity measures-Evidence from a longitudinal sample of non-profit sport clubs in Germany	2012	Sport Management Review	Empirical
A new age of demand-based pricing: An examination of dynamic ticket pricing and secondary market prices in major league baseball	2012	Journal of Sport Management	Empirical
An examination of underlying consumer demand and sport pricing using secondary market data	2012	Sport Management Review	Empirical
Factors affecting the price of luxury suites in major north american sports facilities	2012	Journal of Sport Management	Empirical
Measuring season ticket holder satisfaction: Rationale	2013	Sport Management Review	Empirical
An examination of dynamic ticket pricing and secondary market price determinants in Major League Baseball	2014	Sport Management Review	Empirical
Predicting which season ticket holders will renew and which will not	2014	European Sport Management Quarterly	Empirical
The effect of price dispersion on major league baseball team attendance	2014	Journal of Sport Management	Empirical
Estimating consumer spending on tickets, merchandise, and food and beverage: A case study of a NHL team	2014	Journal of Sport Management	Empirical
On the demand for live sport contests: Insights from the secondary market for National Football League tickets	2016	Journal of Sport Management	Empirical
Dynamic ticket pricing and the impact of time – an analysis of price paths of the English soccer club Derby County	2016	European Sport Management Quarterly	Empirical
NBA primary market ticket consumers: Ex ante expectations and consumer market origination	2016	Journal of Sport Management	Empirical
Female season ticket holders: how their satisfaction is derived differently from males	2018	European Sport Management Quarterly	Empirical
Hashmoney: exploring Twitter hashtag use as a secondary ticket market price determinant	2018	International Journal of Sport Management and Marketing	Empirical
Using a discrete choice experiment to estimate spectators' willingness to pay for professional baseball park sportscape	2019	Sport Management Review	Empirical
Membership versus green fee pricing for golf courses: the impact of market and golf club determinants	2019	European Sport Management Quarterly	Empirical
Built to last: relationship quality management for season ticket holders	2020	European Sport Management Quarterly	Empirical
Predicting fan behavior through egocentric network analysis: Examining season-ticket Holder Renewal	2020	Journal of Sport Management	Empirical

Tennis superstars: The relationship between star status and demand for tickets	2020	Sport Management Review	Empirical
Sporting events and the derived demand for hotels: Evidence from southeastern conference football games	2021	Journal of Sport Management	Empirical
The impact of dynamic ticket pricing on Major League Baseball attendance	2022	International Journal of Sport Management and Marketing	Empirical
If you rebuild it, will they come? The impact of renovated sports facilities on total revenue and attendance	2023	Journal of Sport Management	Empirical
Determining the price of football: An analysis of matchday ticket prices in the English Premier League	2024	European Sport Management Quarterly	Empirical

EC.6   Data Sources

SPORT	DATA SOURCES	API FOR OBTAINING DATA
NFL	https://nextgenstats.nfl.com/	"nflscrapR" R Package
MLB	https://baseballsavant.mlb.com/statcast_search; https://www.mlb.com/stats/	https://sportradar.us/sports-data/
GOLF	https://www.datagolf.com/; https://www.golfstats.com/; https://www.getrealgolfstats.com/	
NBA	https://www.nba.com/stats/	https://github.com/toddwschneider/nba-shots-db

EC.7 Research Questions

In this section, we provide a summary of new research avenues discussed in the main manuscript.

Table EC.12 Revenue Management Theme

Research Questions	Method	Papers for Reference
Sub-theme: Ticket sales		
What is the impact of DTP strategy on game day revenues? What factors influence the success (or failure) of the DTP strategy?	Empirical	Rascher et al. (2007), Drayer and Martin (2010), Drayer and Shapiro (2011), Duran and Pakyardım (2012), Shapiro and Drayer (2012), Tan and Carrillo (2017), Geng et al. (2018), Lewis et al. (2019), Xu et al. (2019), Courty and Davey (2020), Arslan et al. (2022)
Why are some teams hesitant to adopt DTP and what factors affect the decision to implement DTP? More formally, how should a sports organization choose between a variable and dynamic ticket pricing model?	Analytical	
Will higher prices in the secondary market mitigate the negative perception of DTP? Formally, how should a sports organization deal with third-party ticket vendors and ticket resellers when designing a DTP model?	Empirical/ Analytical	
How does ticket bundling interact with DTP?	Analytical	
What is the optimal revenue sharing model between a sports organization and a third-party ticket vendor?	Analytical	
Sub-theme: Sponsorship		
How to bundle traditional media sponsorship with the social/digital media sponsorship inventory?	Analytical	Popescu and Crama (2016), Geng et al. (2018), Bergantinos and Moreno-Ternero (2020), Hino and Takeda (2020), Kumar et al. (2020), Balocco et al. (2025)
How should teams price their social and digital inventories separately?	Analytical	
How should the social media managers of teams determine the optimal schedule for ad placements such that the engagement of fans with sponsors' ads is maximized?	Analytical	
Sub-theme: Concession and merchandise management		
When deciding between add-on pricing and all-inclusive pricing, what key factors should a sports organization consider?	Empirical/ Analytical	Brown et al. (2010), Shulman and Geng (2013), Langhorst (2014), Kosfeld and Schüwer (2017), Geng and Shulman (2015), Geng et al. (2018), Shulman and Geng (2019), Jang and Chung (2021)
What add-ons should be included in a bundle with the tickets, and what should be sold separately?	Empirical/ Analytical	
Should sports organizations tailor add-on strategies to different customer segments to maximize both revenue and fan engagement?	Analytical	
How can a team predict a customer's journey to optimize merchandise inventories?	Empirical	

Table EC.13 Research Questions in New Technologies in Sports Business Theme

Research Questions	Method	Papers for Reference
Sub-theme: Internet of Things (IOT)		
How can IoT wearables be effectively utilized to monitor and enhance recovery protocols for injured athletes?	Analytical	Bolhasani et al. (2021)
Sub-theme: Real-time data statistics		
What is the impact of AI-based tools on attracting new fans to sports? How can leagues, teams, and broadcasters leverage new data and technology to engage with their fans?	Empirical	Behrens and Uhrich (2022)
Sub-theme: Non-Fungible tokens		
How can NFTs be more seamlessly incorporated into existing fan loyalty programs, thereby creating a cohesive bridge between the physical and digital realms?	Analytical	Li et al. (2024)
How can leagues and teams boost awareness and minimize entry barriers for fans by weaving NFTs into already popular fan engagement channels?	Analytical	

Table EC.14 Research Questions in Betting Theme

Research Questions	Method	Related Papers for Reference
How would consumer protection legislation affect the revenue potential of sports betting?	Empirical	Gray and Gray (1997), Park and Manchanda (2015), Birge et al. (2021), He and Klein (2023)
What is the best marketing strategy for sports book operators in an increasingly regulated environment?	Analytical	

Table EC.15   Research Questions in Competition and Rule Changes Theme

Research Questions	Method	Related Papers for Reference
Sub-theme: Rule changes		
How will the further 2024 pitch clock change from 20 to 18 seconds affect game time and team revenues?	Empirical	McHale and Asif (2013), Geenens (2014), Silva et al. (2015)
How will perceptions that NFL games have become less physical affect television audience size and advertising revenues?	Empirical	
How will the changes to cycling rules affect team strategies and the frequency of injuries?	Empirical	
How will the changes introduced in Formula One racing change the frequency of overtaking in Grand Prix events?	Empirical	
How will the March 2025 NFL proposal to ban the short yardage "tush push" play used by the Philadelphia Eagles affect game strategies?	Empirical	
Sub-theme: Competition design changes		
How will the large increase in games for the 2026 World Cup affect revenues and player health?	Empirical	Hall and Potts (2012), McHale and Asif (2013), Geenens (2014), Di Mattia and Krumer (2023), Hall and Liu (2024)
How will the significant realignments taking place in NCAA conference structure affect revenues and fan interest, especially when traditional rivalry games are discontinued as a result?	Empirical	
How will the March 2025 proposal to redesign the seeding of the NFL playoffs to prioritize overall rather than in-division performance affect playoff results?	Empirical	
How will the ongoing fight between the PGA Tour and LIV affect fan interest and TV audience size?	Empirical	
Will MLB and possibly other major sports consider opponent choice as a workable option for their end of season playoff, and if they do so, what will be the effects on tournament integrity and spectacle?	Empirical	

Table EC.16 Research Questions in Service Operations Theme

Research Questions	Method	Related Papers for Reference
Sub-theme: Enhancing service experience		
How effective are off-stadium experiences in improving fan satisfaction?	Empirical	Rosentraub and Swindell (2002), Winand et al. (2013), Behrens and Uhrich (2022)
How does this effectiveness differ among different types of off-stadium experiences?	Empirical/ Analytical	
Are in-stadium and off-stadium fan experiences complements or substitutes in driving fan satisfaction regarding a single game and in driving long-term fan loyalty?	Empirical/ Analytical	
Sub-theme: Impact of pricing on fan experience		
How to measure the (causal) relationship between concession pricing and fan experience empirically?	Empirical	Jarrell and Mulligan (2002), Winand et al. (2013), Behrens and Uhrich (2022)
What is the optimal tradeoff between margin reduction and the sales increment for concessions?	Analytical	
Will a similar positive relationship between add-on price cut and fan experience improvement hold for parking pricing, given that parking has less elastic supply than food and beverages?	Empirical	
Sub-theme: Capacity management		
What is the impact of load management on fan experience in the stadium and at home? How does load management affect short-term team performance and long-term financial outcomes (e.g., ticket sales, merchandise, and media revenue)?	Empirical	Fry et al. (2007), Hellingman et al. (2025)

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