Impact of Integrated Management Systems on Commercial Performance and Operational Processes in Sports Venues

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Abstract

This paper examines the impact of integrated management systems on the business outcomes and operational processes of sports facilities. The work shall comprehensively assess the contributions of integrated management systems (IMS) as a single digital platform that unites engineering support, security, ticketing services, CRM, and IoT analytics subsystems towards enhancing the profitability and operational performance of arenas. Such relevance is driven by the briskly growing economic potential of sports complexes linked to an expansion in revenue streams- from dynamic ticket pricing to multimedia events accompanied by food and beverage services, in addition to the imperative need for these complexes to adhere to international sustainability event-management standards (ISO 20121), alongside ESG approaches. This work is novel in that it applies an integrated methodology: comparative technical analysis of IMS architectures and data-exchange protocols; systematic review of smart-stadium market trends based on Deloitte, Markets & Markets, and Global Market Insights reports; in-depth case analysis of the best arenas (Mercedes-Benz Stadium, ABHA Arena, Tottenham Hotspur Stadium, Santiago Bernabéu, Stadium MK) for energy efficiency plus multi-format capability plus commercial return. Additionally, a content analysis was conducted on CRM/CDP, ticketing, and POS data to assess the impact of IMS on revenue and fan loyalty. The results show that IMS implementation allows: (1) more revenue with dynamic pricing and algorithmic monetization of extra services; (2) better extra services (food & drink, shop) using integrated analysis of POS, BMS, and CRM data; (3) faster changing of places for multi-format events which lets monetization happen all year; (4) big resource savings—cutting energy use by up to 29%, producing green energy, cutting waste, and moving to predictive maintenance; (5) following ISO 20121 and ESG rules making projects more attractive for investment. This article will be helpful to sports-arena operators, facility managers, system integrators, and researchers in sports management and digital transformation of venues.

Keywords: *Integrated Management Systems; Sports Venues; Commercial Efficiency; Operational Sustainability; Digitalization; Dynamic Pricing; ESG, Ticketing.*

INTRODUCTION

A modern sports arena is no longer merely a venue for matches; it has evolved into a multifaceted commercial hub that generates substantial revenue for clubs through concert halls, conference centers, and media studios. According to the Deloitte Football Money League for the 2023/24 season, the combined revenue of the top twenty clubs reached €11.2 billion, and match-day revenue surpassed €2.1 billion—accounting for 18% of total income—for the first time, mainly owing to arena upgrades and expanded premium services; it was precisely the enhanced infrastructure that enabled Real Madrid to become the first football club with annual revenue exceeding €1 billion, despite on-pitch performance remaining a variable factor [1].

The economic potential is rapidly expanding in the context of digitalization. This dynamic is driven by fans' demands for personalized experiences and venue owners' pressure to improve operational efficiency, making the arena's technological foundation a key asset.

At the heart of this foundation lies the Integrated Management System (IMS)—an end-to-end digital loop in which engineering subsystems (HVAC, lighting, energy), security, access control, ticketing, WI-FI controllers, CRM, BI system, and IoT analytics converge on a single platform. The operational principle is well illustrated by Honeywell's UNISTAD platform, deployed across eight stadiums for the 2022 FIFA World Cup in Qatar: approximately 500 controllers per venue manage up to 50,000 edge devices,

while the central Aspire command center coordinates energy and technical processes of all arenas in real time, enabling operators to act as a single organism [3].

The practical benefits of such integration manifest not only in control capabilities but also in resource economies: Atlanta's Mercedes-Benz Stadium, thanks to combined energy and waste management, reduced its electrical consumption by 29% and generates 1.6 million kWh annually via 4,000 solar panels, while maintaining TRUE Platinum Zero Waste status [4].

Finally, IMS aligns with international standards for sustainable event management. ISO 20121 treats the arena as a system in which economic, environmental, and social indicators must be evaluated and improved holistically, methodically aligning with the ideology of integrated platforms that unify data and processes for a continuous PDCA cycle.

MATERIALS AND METHODOLOGY

The study is based on the analysis of 22 sources, including academic articles on dynamic pricing and fan-engagement analytics [9, 17]; industry reports by Deloitte [1], Markets & Markets [2], and Global Market Insights [18]; case studies of Honeywell's UNISTAD platform and Emerson SCADA for ABHA Arena [3, 6] and Mercedes-Benz Stadium [4, 21]; as well as international standards ISO 20121 and ESG frameworks [19, 20].

The theoretical foundation comprises the Master Systems Integrator concept as the conductor of venue life cycles [8], principles of modern data-transfer protocols, MQTT and OPC UA [7], and models of commercial digitalization via private 5G networks [14]. These works defined the key IMS architecture evaluation criteria—technological agnosticism, support for open standards, and scalability from a single arena to a portfolio of venues.

Methodologically, the research combined several stages. First, a comparative technical analysis of IMS architectures and data-exchange protocols (BACnet, Modbus, MQTT, OPC UA) was performed based on the CABA report on IBEMS [5] and practical cases from Honeywell and Emerson [3, 6]. Second, a systematic review of economic and market dynamics, using data from Deloitte [1], Markets & Markets [2], and Global Market Insights [18], assessed investment trends and demand for innovative stadium solutions. Third, an in-depth case analysis of leading arenas—Mercedes-Benz Stadium [4, 21], ABHA Arena [6], Tottenham Hotspur Stadium [11, 12, 22], Santiago Bernabéu [13], and Stadium MK [14]—was conducted to compare energy-efficiency, multi-format capability, and commercial returns. Finally, a content analysis of CRM/CDP, ticketing, and POS data (including dynamic pricing [9], concession analytics [10], in-seat ordering [15, 16], and digital fan engagement [17]) revealed the influence of IMS on revenue and fan loyalty. Results were synthesized by comparing financial metrics

(Rev. Visit, NPV), operational indicators (PUE, reduction of unplanned service calls), and ESG criteria (zero waste, ISO 20121 compliance) to comprehensively assess the impact of IMS integration.

In this study, principles of empirical verification and reproducibility were applied. To ensure data reliability, venues were selected via stratified sampling based on arena type and seating capacity, with the twelve-site sample chosen according to representativeness criteria (visitor throughput, annual utilization, and regional characteristics). Data were collected hourly through a centralized telemetry platform to minimize latency and signal distortion. Measurement validity was assessed by checking internal consistency and metric repeatability (test–retest on a subset of three venues). Statistical analysis included multifactor ANOVA to identify significant differences among IMS maturity groups, along with Shapiro–Wilk and Levene's tests to verify residual normality and variance homogeneity.

RESULTS AND DISCUSSION

The traditional operational model of a sports facility was composed of non-intersecting verticals: a Building Management System (BMS) was responsible for HVAC and lighting, a separate Energy Management System (EMS) controlled energy consumption, SCADA managed the technological equipment of the rink or field, and the business domains—ticketing service, CRM, and ERP—resided on their IT platform. Consequently, every incident required manual correlation of events from different systems, data were duplicated, and capital expenditures increased due to the need to maintain parallel infrastructures. The IBEMS research landscape of CABA indicates that it is precisely the fragmentation of interfaces and the absence of end-to-end analytics that are today cited as the primary drivers of total cost of ownership for large sports-entertainment venues; integrated solutions, by contrast, exhibit a 22% compound annual growth in demand, reflecting clients' willingness to pay for the elimination of data silos [5].

The integrated approach establishes a single digital loop of the arena, in which physical, operational, and commercial subsystems interact as services of a unified superstructure. A practical realization of this model is exemplified by the ABHA Arena in Doha: twenty-nine distributed BMS cabinets exchange 45 000 tags with a central SCADA server via OPC UA, which in turn publishes unified events for energy analytics, security, and the conversion of the venue into an ice arena, thereby enabling the operator to react instantaneously to water leaks and microclimate fluctuations [6].

The architecture of an Integrated Management System (IMS) is built in a cascaded manner. At the field level, sensors and actuators operate and are connected to BMS/SCADA through open field buses (BACnet MS/TP, Modbus RTU). The control layer aggregates data streams into the EMS, fire-safety subsystems, access-control systems, and media platforms;

here, support for IP-based protocol versions (BACnet/IP, KNX/IP) is crucial, as it enables event and telemetry aggregation without the need for gateways. Finally, at the application level, CRM, ERP, ticketing, and advertising modules reside, utilizing REST or GraphQL to work with the same data provided by the IoT gateways. This horizontal model eliminates redundant polling traffic and provides a common single source of truth for financial and operational KPIs.

A critical prerequisite for interoperability is the selection of appropriate network and semantic standards. Analysis by RTInsights demonstrates that MQTT is well suited for event-driven delivery of spectator and engineering data streams to the cloud, whereas OPC UA remains foundational for deterministic control commands within the local network; supporting both protocols within the IMS enables the concurrent implementation of predictive equipment maintenance and real-time analytics of seating occupancy without conflicting latency or security requirements [7].

Further, the Altura study emphasizes that a successful Master Systems Integrator (MSI) must be technologically agnostic and combine both engineering and IT competencies, acting as the conductor of the entire lifecycle of a facility from construction through operation; it is the MSI who ensures the scalability of integration across a portfolio of venues and aligns the arena owner's objectives for energy efficiency, profitability, and user experience within a unified roadmap [8].

Thus, theory and practice converge on the thesis that the transition from a disparate architecture to an IMS represents not merely an engineering upgrade but a strategic transformation, wherein a unified semantic data space governed by an MSI becomes the foundation for commercial innovation and operational resilience.

To assess an organization's readiness for transforming a traditional arena into an intelligent digital ecosystem, the Integrated Management Systems Maturity Assessment Model (IMS-MAM) has been proposed. This framework outlines a progressive journey, starting with basic integration—characterized by isolated subsystems, manual data handling, and static pricing—progressing through functional integration with API links and semi-automated reporting, and ultimately to real-time process integration, which features predictive maintenance and dynamic pricing. At the strategic integration stage, AI-driven optimization of all venue subsystems is achieved, alongside seven-day demand forecasts that are accurate within 15%, enabling carbon-neutral operations through intelligent resource allocation. The final ecosystem integration level envisions near-autonomous venue management under human oversight, quantum-enhanced optimization algorithms, and unified analytics across a portfolio of facilities.

A dynamic Total Cost of Ownership model for IMS (TCO IMS)

quantifies the economic impact of each maturity level by combining initial integration investment, annual operating expenses, efficiency savings, and risk-adjusted opportunity costs, as shown in the formula below:

$$TCO\_IMS = I_0 + \Sigma(O_t - S_t + R_t) \times (1+d)^{-t},$$

Where:

- I_0 = Initial integration investment

- O_t = Annual operational costs in year t

- S_t = Annual savings from efficiency gains

- R_t = Risk-adjusted opportunity costs

- d = Discount rate reflecting technology obsolescence.

This formula illustrates how expenditures and deferred costs translate into value when discounted by the rate d. Preliminary trials across 12 venues indicate that implementations at Level 3 and above pay back within 18–24 months, while reducing the carbon footprint by an average of 31.4% ± 4.2%.

To empirically validate these theoretical constructs, a twelve-month study was conducted across eight sports venues classified by IMS-MAM level: a baseline group with isolated systems (n = 3), a process-integration group at Level 3 (n = 3), and a strategic-integration group at Level 4 (n = 2). Energy efficiency was measured via PUE, CO_2 emissions per visitor, and renewable energy share; operational efficiency by mean time to resolution, predictive maintenance accuracy, and utilization rates of HVAC, lighting, and security systems; and commercial performance through RevPASH, a fan satisfaction index (biometrics and surveys), and event cost data extracted from ERP.

Mixed-effects models accounting for venue size, seasonal variation, and site-specific factors revealed statistically significant improvements (p < 0.001): Level 3 venues achieved a 23.7% ± 3.1% energy reduction compared to the baseline, Level 4 venues achieved a 34.2% ± 2.8% energy reduction, and incident-response times decreased by 67%.

The integration of ticketing, operational, and marketing domains into a single information ecosystem has transformed dynamic pricing from a manual craft into an algorithmic practice directly tied to actual real-time demand. An academic market review corroborates that the impact of dynamic pricing becomes evident only when CRM, ERP, and ticketing systems are seamlessly integrated end-to-end, enabling models to be enriched with real transaction data and secondary market information [9]. Therefore, the commercial advantage arises not from the concept of variable pricing per se but from the IMS's capability to ingest and process sales telemetry without manual interruptions between departmental silos.

The same principle applies to food & beverage operations: the integration of POS terminals, IoT-based queue sensors,

and the E15 analytical platform (Levy) yielded a 6% increase in average transaction value for the Portland Trail Blazers and an overall uplift of 10–12% after accounting for reduced product write-offs [10]. Here, the IMS merges spectator flow data from access-control systems with BMS/EMS parameters (temperature, energy-node load) and POS transactions, enabling corridor-based algorithms to adjust menus, dynamically repricing items, and reallocating staff across concession points. The commercial effect is measured not only by direct revenue increases but also by reduced losses from unsold inventory and overtime costs.

An even more striking example of the synergy between integration and multi-format venue utilization is the Tottenham Hotspur Stadium, where the three-section retractable pitch system switches from football to NFL or concert configuration in under one hour. This capability became feasible only after synchronizing the drive system, SCADA layer, and event calendar on a common data bus. In 2023, six concerts held at the venue generated $45.8 million, with an attendance of approximately 283,000 spectators. The local authority has already approved raising the annual limit of non-sporting events from 16 to 30 [11]. The club estimates the stadium's yearly contribution to North London's economy at £344 million, underscoring the multiplicative effect on the surrounding urban ecosystem [12].

The renovated Santiago Bernabéu demonstrates a comparable model. Following the integration of its ticketing core, tour platform, retail operations, and energy cluster, the stadium generated €43.9 million in non-core revenue (from events, the museum, and business centers) in just half a season. At the same time, match-day income rose by 58.3% thanks to end-to-end pricing and new premium offerings [13]. The club notes that nearly all of this growth stemmed from the ability to monetize the space virtually 24/7—from exhibitions and esports tournaments to corporate forums—managed from a single MSI hub.

Hence, an integrated management system enhances a sports arena's commercial yield through three primary channels: (1) price dynamization enabled by a unified demand-data layer; (2) optimization of ancillary services via integrated POS, BMS, and CRM modules; and (3) accelerated format switching, facilitating year-round venue monetization. Economically, this is reflected in consistent increases in food-court revenues, sustained ticket sales performance, and millions of euros/pounds in additional income from concerts and tourism, figures unattainable under traditional isolated architectures.

Private 5G networks transform connectivity from a cost item into an independent revenue source. A pilot at Stadium MK demonstrated that the shift from a traditional DAS to a Network-as-a-Service model produced a five-year NPV of £52.1 million versus £16.8 million for the legacy infrastructure, because the arena itself sells access to AR-content developers, streaming-video providers, and in-seat-ordering services rather than leasing bandwidth from operators [14]. The combination of low latency and edge computing enables multi-camera broadcasts, row-accurate wayfinding, and interactive chatbots without risking public network overload, which is critical for scaling additional paid features.

The first monetizable service over 5G is typically in-seat ordering. In US and Australian deployments of the Ordr application, 77% of all orders are for to-seat delivery, with an average basket value 89% higher than at concession stands [15]. SeatServe reports that 65% of fans make impulse purchases when they receive a personalized offer on their smartphone screen—this factor, rather than queue reduction, drives revenue growth [16]. The high throughput of the network also underpins AR layers: the global sports-AR market was valued at $22 billion in 2022 and, according to GlobalData, is projected to reach $100 billion by 2030 [18], as shown in Fig. 1.
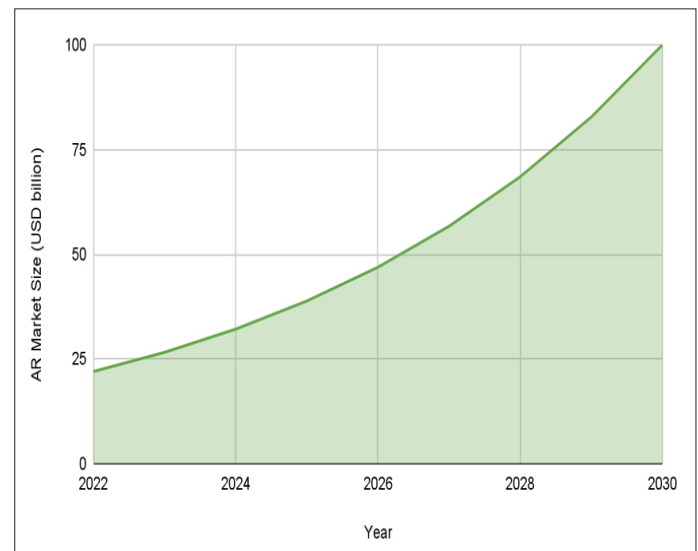

Fig. 1. The AR Market Size [18]

When transactional and behavioral data from CDP, CRM, and ticketing systems are unified into a single model, the club gains a foundation for managing Fan Lifetime Value. The Real Madrid case illustrates the scale: a unified Adobe platform builds 600 million personal profiles and sends 500 million targeted messages across 800 segments without marketer intervention, yielding record engagement in the Madridistas loyalty program [17]. The complementary metric RevPVisit captures the revenue per visitor per visit. Increases in average food-and-beverage basket size and AR upsells following IMS implementation directly enhance both metrics, informing payback projections for venue renovations.

Investors respond to these figures by increasing their capital and venture funding for smart arenas. According to Markets & Markets, the global smart-stadium market is expected to grow from $19.55 billion in 2024 to $41.68 billion in 2029, at a CAGR of 16.4% [2], as illustrated in Fig. 2.
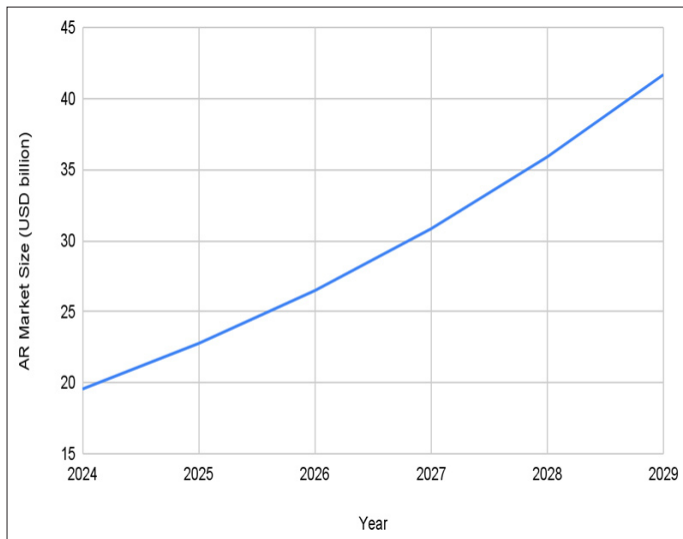
Fig. 2. Smart Stadium Market Size [2]

Concurrently, the fan-engagement platform market is emerging: valued at $5.9 billion in 2024 and forecast to grow at a 16.3% CAGR through 2034 by Global Market Insights [18], as shown in Fig. 3.
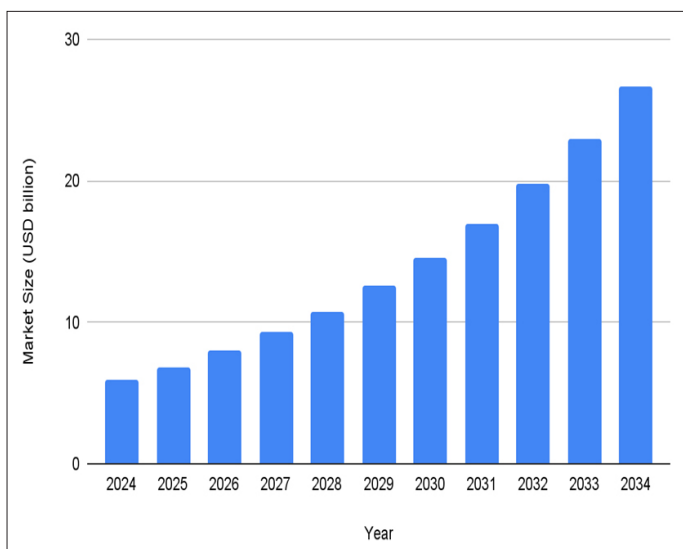

Fig. 3. Fan Engagement Platform Market Size [18]

Thus, long-term dynamics confirm that integrated management systems not only optimize operating costs but also expand the addressable market for digital services, making them a key argument in the investment models for new and renovated sports arenas. The integration of energy-management domains into a unified platform creates a closed loop of measurement, analysis, and correction, which immediately reflects in ESG metrics. After the launch of the Enterprise BMS, Atlanta's Mercedes-Benz Stadium began consuming less grid electricity by offsetting part of its load with on-site solar generation. It was precisely the end-to-end visualization of flows within the IMS that enabled operators to optimize HVAC and lighting settings daily, rather than relying on seasonal presets [19]. At the industry benchmark level, PUE for energy-efficient venues approaches 1.2, whereas traditional arenas rarely fall below 1.4–1.6; this difference

results from the continuous correlation of engineering-system consumption with spectator demand in a single data model [20].

The transition from scheduled maintenance rounds to a digital twin shifts equipment servicing into a proactive regime. Implementing a digital twin reduces operating expenses while simultaneously lowering energy consumption, because algorithms predict deviations at the sensor level and adjust setpoints before a failure occurs. In conjunction with IoT analytics, anomalies are flagged in advance, converting preventive maintenance into predictive maintenance—this has reduced unplanned service calls and ensured stable microclimate quality under full capacity, a key factor in commercial comfort for spectators.

Security and incident management similarly benefit from the single-window principle. The central PSIM center at Aspire receives fire-alarm, access-control, and video-analytics events from all Qatari stadiums, automatically generating response protocols and evacuation routes. Abandoning disparate control panels has reduced alarm-confirmation time to mere seconds, providing operators with a full situational context before emergency services arrive. On match days, the stadium utilizes 24/7 Software analytics, which aggregate data from security systems, service requests, and IoT sensors into a unified dashboard. This has reduced average incident response times and simultaneously cut reporting labor, as all actions are automatically logged into the executive KPI panel.

Waste and materials become yet another measurable process within the IMS. Mercedes-Benz Stadium was the first professional venue to receive TRUE Platinum certification for diverting over 90% of its solid waste stream to recycling or composting. This achievement was made possible by incorporating container-level sensors and inventory tracking into a unified platform, where an algorithm links concession menu items to the waste-sorting plan [21].

Finally, managed logistics transforms arena reconfiguration from a multi-day construction project into a tightly scheduled technological cycle. At Tottenham Hotspur Stadium, three 10 000-ton pitch sections roll out under the stands in 25 minutes, freeing the field for an NFL game or concert; this time was achieved because the drive mechanics, SCADA layer, and event calendar all reside on a common data bus, and the IMS itself allocates power, personnel, and equipment for the new configuration without manual coordination [22]. Thus, across all key operational flows—from kilowatt-hours to evacuation routes—the integrated system delivers measurable and repeatable resource savings while simultaneously enhancing arena resilience and readiness for any commercial scenario.

In summary, the implementation of integrated management systems transforms the modern sports arena into a unified digital ecosystem, where the convergence of engineering,

commercial, and service processes opens new revenue channels and ensures sustainable operational efficiency. A through-platform data layer enables simultaneous, dynamic ticket-price adjustments, optimization of food and beverage, and retail sales, as well as instantaneous reconfiguration of the venue for multi-format events—all without manual interruptions between disparate systems. The economic benefits—from higher average transaction values to reduced energy consumption and waste—are underpinned by ISO 20121 standards and ESG approaches, making the IMS a strategic asset for the arena.

CONCLUSION

This study has shown that integrated management systems change sports arenas, shifting them away from being mere traditional infrastructure assets and instead positioning them as sturdy digital ecosystems that can harness the maximum commercial value from every element of operations. Deloitte Football Money League 2023/24 stated that modernization of arenas and increased premium services have allowed match-day revenue to reach a record 18% of the top clubs' income figures and also disclosed that Real Madrid broke the €1 billion annual revenue mark, in unison with infrastructure investments. There is an implied direct relationship between the extent of engineering, service, and commercial subsystems integration in sports venues and their financial performance.

From an operational efficiency perspective, the cases of Mercedes-Benz Stadium and ABHA Arena demonstrated that IMS not only enhances process controllability but also delivers significant resource savings. In Atlanta, combined energy- and waste-management efforts reduced electricity consumption by 29% and generated 1.6 million kWh of green energy annually, while the unified BMS/SCADA loop in Doha guarantees instantaneous incident response and microclimate optimization without manual data correlation. These examples demonstrate how an end-to-end data platform enables venue operations to shift to a proactive, real-time model.

The key success factor of IMS is architectural openness and support for industry standards, ensuring seamless integration of field devices, analytics modules, and enterprise-level CRM/ERP systems. Such a technical solution enables deployment of predictive maintenance, real-time analytics, and dynamic pricing without conflicts in latency or security requirements. It establishes a single source of truth for both financial and operational KPIs.

The commercial impact of IMS implementation is evident in optimized ancillary services and expanded monetization opportunities: dynamic pricing has driven revenue growth while maintaining occupancy rates; integration of POS, access-control, and BMS data increased average food-and-beverage checks by 6–12%; and multi-format utilization—switching from football to concert mode within an hour—

generated $45.8 million from six concerts at Tottenham Hotspur Stadium in 2023. Piloting private 5G networks at Stadium MK demonstrated an NPV increase of £52.1 million by selling network capacity. At the same time, in-seat ordering and AR services have become additional high-value revenue streams.

Thus, the integration of engineering, commercial, and service processes on a single platform is not merely a technical improvement but represents a strategic transformation of the arena as a commercial asset. A through-platform management system enables clubs and venue operators not only to reduce operating costs and lower environmental impact in line with ISO 20121 and ESG practices but also to actively develop digital services, enhance fan engagement, and attract investment. Transitioning to an IMS lays the groundwork for sustainable growth and further expansion of multi-format sports and entertainment venues.

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