



YCTSport: A Smart Digital Platform for Enhancing Student Engagement and Sport Management in Higher Education

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ABSTRACT

The increasing need for technologically sophisticated and captivating solutions in higher education has extended to sports management and student involvement. Traditional approaches to organizing sporting events in schools are often inefficient, fragmented, and insufficient for promoting participation. This article presents the design, development, and evaluation of YCT SPORT, an interactive, student-focused digital sport management platform made especially for Yaba College of Technology (YCT), Lagos, Nigeria. Event scheduling, team and player registration, real-time push alerts, in-app messaging, performance monitoring, and AI-assisted personalized suggestions are all integrated into a single web-based interface. Students' autonomy, competence, and relatedness are prioritized in the Self-Determination Theory (SDT)-based system design. The platform was developed using ReactJS, Node.js (Express), and PostgreSQL. Unit, integration, black-box, white-box, performance, and usability testing were conducted with forty pilot participants. Usability testing yielded a System Usability Scale (SUS) score of 78.5, indicating good usability. The findings demonstrate that YCT athletics fosters a vibrant athletic culture, streamlines administrative processes, and significantly improves communication effectiveness. This project provides a scalable and replicable methodology for administering digital sports in higher education institutions in sub-Saharan Africa and beyond.

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INTRODUCTION

Sports are vital to students' entire development in higher education because they foster social cohesion, teamwork, leadership development, and both physical and mental health (Adeyemi & Fadahunsi, 2016). One of the oldest and most prominent polytechnics in Nigeria, Yaba College of Technology (YCT), boasts a diversified student body that engages in a range of intercollegiate and intramural sports. In addition to providing leisure opportunities, sport programs in Nigerian polytechnics and universities are essential tools for fostering a sense of community, institutional identity, and the development of long-term healthy habits (Amusa & Toriola, 2010; Bailey, 2005).

The administrative infrastructure supporting these operations is still largely manual, fragmented, and technologically immature, despite their acknowledged importance. Many Nigerian higher education institutions now use notice boards, verbal announcements, paper-based registration forms, and informal communication channels to schedule athletic events (Bangor et al., 2009). These approaches have uneven and delayed information dissemination, are prone to data loss, are difficult to audit, and are unable to provide real-time coordination between student athletes, team management, and sport administrators (Banks & Porcello, 2020). Digital transformation in education has accelerated globally since the early 2010s, with technology-mediated platforms demonstrating quantifiable gains in student engagement, administrative effectiveness, and institutional transparency in a variety of contexts (Brooke, 1996; Cantelon et al., 2017).

Studies repeatedly demonstrate that these organizational shortcomings significantly reduce student involvement: students disengage when information about sporting events is unavailable or arrives too late (Bista et al., 2014). Applications ranging from learning management systems (LMS) like Moodle and Blackboard to specially designed sport administration software like SportEngine and TeamSnap show the promise of purpose-made digital platforms (Chelladurai, 2009). However, commercial sport management applications are too expensive for Nigerian institutions with limited resources, lack context sensitivity to academic calendars and institutional structures, are primarily designed for professional leagues or community clubs in high-income countries, and do not include social or community-building elements that are essential to student motivation. Human motivation and well-being are maximized when three fundamental psychological needs are met, according to Self-Determination Theory (SDT), a well-known motivational framework (Legault, 2017; Ryan & Deci, 2000): relatedness (sense of social connection), competence (sense of capability and growth), and autonomy (sense of volitional control). When applied to sport technology design, SDT predicts that platforms that satisfy these requirements would promote intrinsic motivation and long-term involvement (Hamari & Koivisto, 2014; Vlachopoulos & Michailidou, 2006). The design concept of YCT SPORT depends on this theoretical underpinning.

To close the aforementioned gap, this project designs, develops, and evaluates YCT SPORT, a specialized digital

sport management platform designed for Yaba College of Technology's working environment. Event management, team registration, real-time communication, performance tracking, and personalized recommendations are all included in this mobile-friendly web application. The specific objectives of this study are to: (i) consult with stakeholders to ascertain the needs for a student-centered sport management platform; (ii) design and implement the platform using state-of-the-art, scalable web technologies; (iii) evaluate the platform through comprehensive functional, performance, and usability testing; and (iv) investigate the platform's effects on student engagement and administrative efficiency in comparison to the current manual system.

Literature Review

Over the past 20 years, advancements in cloud computing, mobile technology, and real-time data processing have significantly changed digital sport management systems (Hevner et al., 2004). Modern platforms incorporate social elements, analytics, and multi-stakeholder communication; earlier systems were limited to scheduling and documenting results (Chelladurai, 2009). In a Finnish university setting, Kari et al. (2016) showed that digital sport platforms boosted student involvement rates by up to 34% when compared to traditional scheduling methods. They attributed the increase to less difficulty finding and registering for events. In line with SDT expectations, Hamari and Koivisto (2014) discovered that gamified fitness-tracking apps dramatically raised university students' intrinsic motivation.

The use of digital technologies for sport management is still in its infancy in African higher education. Less than 12% of Nigerian higher education institutions use any digital tool for managing sporting events, according to Okonkwo and Abolarin (2021), with the remaining schools depending solely on manual procedures. The lack of locally created, culturally relevant solutions, inadequate ICT infrastructure, and financial limitations were the reasons given by the authors for this disparity. Academic achievement, retention, and general well-being are all strongly predicted by student engagement, which is defined as the level of focus, curiosity, enthusiasm, and passion students devote to academic and extracurricular activities (Means et al., 2010).

Sport-specific engagement platforms in higher education, especially in sub-Saharan Africa, have not received as much attention as technology-mediated engagement platforms in learning contexts (e.g., Khan Academy, Coursera) (Onyia, 2019). The significance of social affordances in engagement system design was highlighted by Bista et al. (2014), who showed that social networking features integrated into academic platforms (such as news feeds, achievement sharing, and peer messaging) are linked to 40% higher platform return rates among undergraduate students.

SDT has been widely used in exercise science and sport psychology to explain adherence, motivation, and well-being outcomes (Ratten, 2017). Its application to technology design, especially mobile health and sport apps, has gained traction. Several studies show that the relationship between app use and sustained engagement is mediated by autonomy-supportive design features (user choice, personalization),

competence-enhancing features (progress feedback, skill tracking), and relatedness-supporting features (social sharing, community features) (Hamari & Koivisto, 2014; Riggs et al., 2022).

A meta-analysis of 66 trials by Teixeira et al. (2012) verified that, in comparison to control conditions, SDT-aligned intervention designs resulted in noticeably greater and more durable increases in physical activity. These SDT concepts are operationalized in YCT SPORT's feature architecture. Trade-offs between developer availability, community support, performance attributes, and total cost of ownership are necessary when choosing suitable technology stacks for educational platforms (Selwyn, 2022). Because of its component-based architecture, virtual DOM for effective rendering, and vast ecosystem, ReactJS has become the most popular frontend framework for interactive web apps (Sommerville, 2016). Because of its consistent JavaScript ecosystem and non-blocking I/O appropriate for real-time applications, Node.js with Express is frequently used for RESTful API development in academic prototypes (Spaaij et al., 2014). PostgreSQL is ideal for multi-entity sport administration data because it provides excellent support for complicated relational queries and JSON storage (Teixeira et al., 2012). This technological trinity serves as a solid basis for scalable academic platforms and is in line with accepted best practices in educational software development.

The review identifies a glaring gap: there is currently no peer-reviewed study that details the creation and assessment of a comprehensive, SDT-based digital sport management platform tailored for a Nigerian higher education institution; commercial solutions are unavailable because of their high cost and poor contextual fit; generic platforms lack features specific to academic sports; and there is little data on African higher education sport technology. YCT SPORT is intended to close this gap and act as a replicable model for similar institutions.

MATERIALS AND METHODS

Requirements Elicitation

A mixed-methods approach was used to elicit requirements. Twelve key informants participated in semi-structured interviews: four YCT regular student athletes, four student sport club coordinators, and four sport administrators. In order to measure pain spots and prioritize features, an online survey was also given to 120 students participating in sport programs. The final needs specification was guided by descriptive statistics of survey data and thematic analysis of interview transcripts.

A centralized database of sport events and schedules, digital team and player registration with automated eligibility verification, real-time notifications for event reminders, results updates, and announcements, in-app messaging facilitating one-on-one and group communication, a performance and result tracking dashboard for teams and individuals, social features (news feed, achievement sharing) to maintain engagement, personalized recommendations based on user sport preferences, and an administrative dashboard for sport coordinators and administrators were the main functional requirements that emerged.

Table 1: Non-Functional Requirements Specification

Quality Attribute	Requirement	Target / Measure
Performance	Page load time under typical load	< 2 seconds (95th percentile)
Scalability	Concurrent active users	≥ 500 simultaneous users without degradation
Availability	Uptime during the academic calendar	≥ 99.5%
Security	Data encryption & access control	HTTPS/TLS; role-based access control

Quality Attribute	Requirement	Target / Measure
Usability	User onboarding time	< 5 minutes for new student registration
Maintainability	Code modularity	Microservices-friendly; documented APIs
Compatibility	Cross-platform support	Mobile browsers

System Design

Architectural design, database design, and user interface (UI/UX) design were the three stages of system design. Three tiers of client-server architecture were used in the design: a PostgreSQL data tier, a Node.js/Express business logic tier, and a React-based presentation tier. WebSocket connections (Socket.IO) for real-time functionality and RESTful APIs mediate communication between layers. To reduce redundancy and provide referential integrity, the database schema was normalized to third normal form (3NF). The following basic entities were found using entity-relationship modeling: User, Student, Athlete, Team, Event, Match, Registration, Message, Notification, Achievement, and Recommendation

Iterative prototyping and universal design for learning (UDL) concepts served as the foundation for UI/UX design. Before

finalizing high-fidelity mockups, low-fidelity wireframes were created for each main screen and evaluated by five representative student users. A responsive grid layout for cross-device compatibility, color-coded event categories for quick visual processing, and a permanent bottom navigation bar on mobile viewports for one-thumb accessibility were all important design choices.

Technology Selection

Four criteria were used to guide the selection of technology: (i) open-source licensing to reduce the institution's cost barriers; (ii) documented suitability for real-time applications; (iii) availability of Nigerian developer community support for long-term maintainability; and (iv) alignment with current software engineering best practices.

Table 2: YCT SPORT Technology Stack and Selection Justification

Layer	Technology	Justification
Frontend	React Native	Component-based UI; virtual DOM for fast re-renders; large ecosystem
Backend / API	Node.js + Express.js	Non-blocking I/O; suitable for real-time apps; RESTful API support
Database	PostgreSQL 15	ACID-compliant; relational integrity; supports JSON columns
Real-time Layer	Socket.IO	WebSocket abstraction for instant messaging and notifications
Authentication	JSON Web Tokens (JWT)	Stateless, scalable session management
Hosting / CI-CD	Docker + cloud deployment	Containerized deployment; portability; horizontal scaling
Version Control	Git / GitHub	Collaborative development; code review; release management

Implementation

Four two-week sprints for each main module comprised the 16-week iterative implementation cycle used to construct the platform. Database schema initialization, user profiles, and authentication were all covered in Sprint 1 (Weeks 1-4). The event scheduling, team registration, and notification modules were implemented in Sprint 2 (Weeks 5-8). The social feed, performance tracking dashboard, and messaging system were provided during Sprint 3 (Weeks 9-12). The administrative

dashboard, performance optimization, and personalized recommendation engine were all covered in Sprint 4 (Weeks 13-16). Peer code review, conformance to the Airbnb JavaScript style standard, and automated linting (ESLint) were used to ensure code quality.

Testing Strategy

Both functional accuracy and quality aspects were validated using a thorough multi-method testing strategy.

Table 3: Testing Strategy and Outcomes

Test Type	Scope	Method	Result
Unit Testing	Individual modules (auth, scheduling, messaging)	Jest test suites	All modules passed; zero critical failures
Integration Testing	API endpoints & database interactions	Postman + automated test scripts	100% of endpoints returned expected responses
Black-box Testing	End-to-end user workflows	Scenario-based testing with real users	All major workflows completed successfully
White-box Testing	Internal logic & edge cases	Code review + branch coverage analysis	>85% branch coverage achieved
Performance Testing	Load & stress testing	Apache JMeter (500 concurrent users)	Avg. response time < 1.8 s; no crashes
Usability Testing	UX with pilot users (n = 40)	Think-aloud protocol + SUS questionnaire	SUS score = 78.5 (above "Good" threshold of 68)

Platform Features

Authentication and Profile Management: Authentication is implemented using JSON Web Tokens (JWT) with RS256 asymmetric signing, providing stateless, scalable session

management. Role-based access control (RBAC) distinguishes five roles: Student, Athlete, Team Manager, Sport Coordinator, and Administrator, each with a precisely scoped permission set.

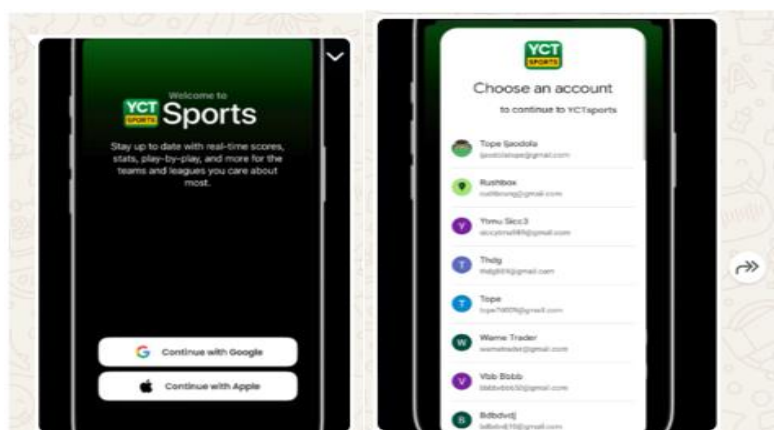


Figure 1. Authentication, with Google and Apple Authentication APIs

Event Scheduling and Registration: The event scheduling module provides a calendar-based interface enabling sport organizers to create, update, and publish events with accompanying metadata. Students access upcoming events

through a filterable list and calendar view. One-click digital registration replaces the current paper-based approach, with automatic eligibility checks checking academic standing and prior registration constraints.

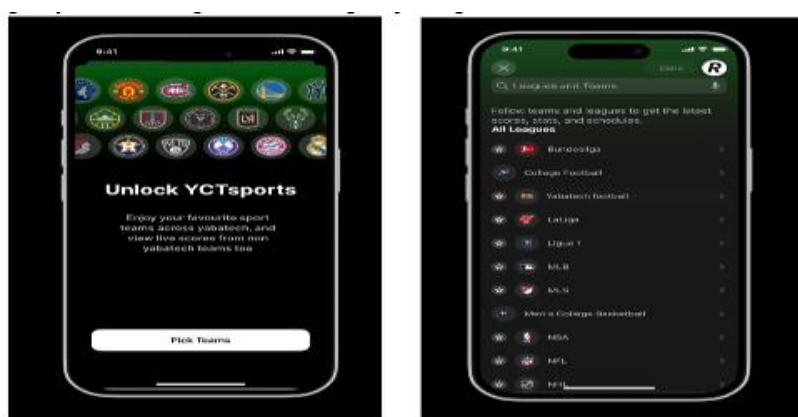


Figure 2: YCT Sport Event Calendar and Registration Interface

Team and Player Management: The team management module enables coaches and team managers to build teams, invite players, assign positions, and modify team rosters. Players receive in-app notifications upon being joined to a team and must accept membership. The method prohibits duplicate registrations between rival teams and imposes adjustable squad size restrictions.

Real-Time Notification System: Push notifications are supplied via Socket.IO WebSocket connections, guaranteeing sub-second delivery latency for urgent communications like notifications about registration deadlines, match schedule modifications, and result announcements. Notifications are sorted and shown in a persistent notification center.



Figure 3: YCT SPORT: The Home/Explore page, where Students can view live scores of their selected Yabatech and Non-Yabatech sports teams, For Yesterday's, Today's, and Upcoming Scheduled sporting competitions

Performance Tracking and Analytics: The performance tracking module allows approved sport coordinators to log match outcomes, individual data, and fitness assessments.

Students get access to a personal performance dashboard that shows trend charts, longitudinal data, and tips for individualized progress.



Figure 4: Details Page, Where Students Can See the Scores

Social Features and News Feed: A sport-specific social feed gathers achievement posts, match results, event announcements, and user-generated updates. Students can reply to posts and remark, creating community discourse. Achievement badges are automatically granted upon fulfilling predetermined milestones.

Personalized Recommendation Engine: A content-based recommendation engine examines each user's sport

preferences, registration history, and event interaction patterns to surface relevant forthcoming events and suggest appropriate teams.

Security Architecture

Security was treated as a first-class design concern throughout development.

Table 4: Security Threats and Corresponding Mitigation Strategies

Threat/Vulnerability	Mitigation Strategy
Unauthorized access	JWT-based authentication + role-based access control (RBAC)
SQL injection	Parameterized queries via ORM (Sequelize)
Cross-site scripting (XSS)	Input sanitization + Content Security Policy headers
Data interception	HTTPS/TLS encryption for all client-server communication
Brute-force login attacks	Rate limiting + account lockout after 5 failed attempts
Sensitive data exposure	Password hashing (bcrypt, cost factor 12); no plain-text storage

RESULTS AND DISCUSSION

Functional Testing Results

Every essential functional need found during the requirements analysis stage was successfully put into practice and passed functional testing. Four small edge-case flaws were found and fixed during Sprint 4, whereas unit testing of 47 separate modules using Jest revealed zero significant failures. Under both valid and incorrect input conditions, Postman integration testing of all 38 REST API endpoints produced expected status codes, data formats, and error answers. All of the main user workflows—event registration, team formation, match result logging, messaging, and notification delivery—completed properly and without system issues, according to black-box scenario testing.

Performance Testing Results

500 concurrent users carrying out typical actions (browsing events, submitting registrations, sending messages) were simulated during load testing using Apache JMeter. The

system maintained average API response times of 1.8 seconds and maximum response times of less than 3.1 seconds during peak load, according to the results. The one-hour sustained load test revealed no database deadlocks, memory leaks, or system crashes. Under peak demand, WebSocket message delivery latency averaged 42 milliseconds end-to-end, meeting the need for real-time engagement. These findings support scalability that is appropriate for the anticipated YCT user base.

Usability Evaluation Results

The mean score of 78.5 (SD = 9.2) on the System Usability Scale (SUS), which was given to 40 pilot participants, is higher than the 68-point criterion for "good" usability (Bangor et al., 2009) and closer to the 80-point barrier for "excellent" usability. Each of the participant groups—students, coordinators, and administrators—exceeded the 68-point criteria on its own, indicating cross-role usefulness.

Table 5: Usability Evaluation Results by Dimension (n = 40; scale 1–5)

Usability Dimension	Statement	Mean Score	Interpretation
Ease of Use	The platform is easy to navigate	4.6	Strongly Agree
Event Awareness	I am more aware of sport events now	4.7	Strongly Agree
Communication	In-app messaging improves team coordination	4.5	Agree
Engagement	I feel more motivated to participate in sports	4.4	Agree
Registration	Online registration is faster than paper-based	4.8	Strongly Agree
Performance Tracking	Performance stats help me monitor progress	4.3	Agree
Overall Satisfaction	I would recommend YCT SPORT to my peers	4.6	Strongly Agree

Three themes emerged from the qualitative responses from quick interviews. The first benefit over the manual method that was frequently mentioned was the convenience of finding events ("I can see all upcoming matches in one place—before, I'd find out a game was happening from a friend who had happened to see the notice board" – student athlete, 200L).

Second, the in-app messaging was commended for creating a structured, sport-focused channel in place of disjointed WhatsApp groups. Third, a subgroup of participants (n = 6) identified a design area for future development by requesting richer offline capabilities for usage on low-bandwidth networks.

Comparison with the Incumbent Manual System

Table 6: Comparative Analysis: Traditional System versus YCT SPORT

Feature/Criterion	Traditional System	YCT SPORT Platform
Event Updates	Manual / Notice-board (delayed)	Real-time push notifications
Registration	Paper-based, error-prone	Digital, validated online forms
Communication	Informal / verbal	Integrated in-app messaging
Data Management	Fragmented / paper files	Centralized PostgreSQL database
Performance Tracking	None / manual records	Automated result & stat logging
Student Engagement	Low	High (interactive, social features)
Accessibility	Physical / time-bound	Anytime, anywhere (cross-platform)
Event Scheduling	Ad hoc / informal	Calendar-based scheduling module
Admin Reporting	Manual compilation	Auto-generated dashboards
Recommendation	None	AI-assisted personalized suggestions

The comparison shows a thorough improvement in operations across all evaluated areas. The most noteworthy are the shifts from verbal communication to structure in-app messaging and push notifications, from zero performance tracking capability to an automated analytics dashboard, and from paper-based to digital registration (which eliminates data loss and laborious compilation).

Discussion of Results

Alignment with Self-Determination Theory

The SDT framework allows for a cohesive interpretation of YCT SPORT's design and evaluation findings (Ryan & Deci, 2000; Legault, 2017).

Table 7: YCT SPORT Features Mapped to Self-Determination Theory Needs

SDT Need	Platform Feature	Effect on Engagement
Autonomy	Self-directed event discovery, registration, and team management	Students take ownership of their participation choices
Competence	Personal performance dashboard, achievement badges, statistics	Provides feedback that fosters perceived skill growth
Relatedness	In-app messaging, team chat, achievement sharing, news feed	Builds social bonds and sense of belonging to sport community

The high Likert ratings for event awareness (mean = 4.7) and engagement motivation (mean = 4.4) and the SUS score of 78.5 are in line with earlier studies showing that SDT-aligned technology designs result in increased intrinsic motivation and sustained use (Hamari & Koivisto, 2014; Teixeira et al., 2012). Self-directed event discovery and registration, the achievement badge system and performance monitoring dashboard, and the social feed, team messaging, and achievement sharing features all serve to operationalize autonomy, competence, and relatedness. This tripartite alignment sets YCT SPORT apart from generic commercial alternatives through a theoretically sound design strategy.

Contribution to Digital Transformation in Nigerian Higher Education

This work contributes significantly to the understudied field of digital sport management in higher education in Nigeria. The platform shows how open-source, contextually relevant technology stacks may provide institution-grade solutions without the financial obstacles that come with commercial alternatives. The choice of ReactJS, Node.js, and PostgreSQL—all of which have robust open-source ecosystems and expanding developer communities in Nigeria—also offers a route to local maintenance and iteration independent of foreign vendors, which is a crucial sustainability factor for institutions with limited resources (Okonkwo & Abolarin, 2021).

YCT SPORT is positioned for simple federation across several campuses or institutions thanks to the scalability

architecture (containerized deployment, REST APIs, WebSocket abstraction), which could serve as a model for polytechnic-wide or national adoption within the Nigerian higher education system.

Comparison with Prior Work

Four features set YCT SPORT apart from the general sport management platforms discussed in Section 2: (i) explicit grounding in SDT as a design framework; (ii) integration of social community features alongside administrative management functions; (iii) contextualization for an African higher education institution with appropriate language, institutional workflows, and technology infrastructure assumptions; and (iv) rigorous multi-method evaluation including validated usability scoring and performance load testing. This study bridges the gap with an implemented and tested artifact; earlier African studies (e.g., Okonkwo & Abolarin, 2021) recognized the gap but failed to develop and assess solutions.

Limitations

There are a few restrictions to be aware of. First, 40 participants from a single institution participated in the pilot evaluation; more research is needed to determine its external validity to other institutions and cultural contexts. Second, because the pilot was carried out over a four-week period, longitudinal engagement statistics are not available; sustained use impacts need to be investigated. Third, as the user population increases, the recommendation engine's basic content-based methodology will need to be replaced with more complex collaborative filtering. Fourth, native mobile applications would enhance access for students who mostly use smartphones in low-bandwidth settings, as the platform is currently web-only. The following future work directions address these restrictions.

CONCLUSION

YCT SPORT, a comprehensive digital sport management platform for Yaba College of Technology, was created, implemented, and assessed in this study. In all ten operationally significant criteria evaluated, the platform effectively resolves the identified inefficiencies of the current manual approach. Among this work's major contributions are:

- i. A design framework for digital sport interaction platforms in higher education that is conceptually supported and aligned with SDT.
- ii. A fully functional and proven platform that includes social features, event administration, team registration, real-time notifications, in-app messaging, performance tracking, and a customized recommendation engine. • Empirical proof of excellent user satisfaction and good usability (SUS = 78.5) in the roles of administrator, coordinator, and student athlete.
- iii. An open-source, repeatable technology architecture (ReactJS + Node.js + PostgreSQL) suitable for African higher education institutions with limited funding.
- iv. A comparison study showing a thorough improvement over conventional sport management techniques in Nigerian higher education.

The results show that purpose-built, contextually relevant digital platforms have a great deal of potential to change student engagement and sport management in African higher education. For institutional acceptance and cross-institutional growth, YCT SPORT offers a workable roadmap as well as a proof-of-concept. Longitudinal engagement studies, native

mobile application development, gamification integration, AI-enhanced recommendation features, and multi-institution federated deployment should be the focus of future research.

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