Advance Sustainable Science, Engineering and Technology (ASSET)
Vol. 8, No.1, January 2026, pp. 02601025-01 ~ 02601025-011
ISSN: 2715-4211 DOI: https://doi.org/10.26877/asset.v8i1.2735

SIMPORA: An Android-Based Data Management and Analytics Framework for Enhancing Community Sports Ecosystems

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Abstract. The increasing adoption of digital technologies in sports management highlights the need for efficient, data-driven systems that enhance community engagement and program evaluation. However, regional sports organizations in Indonesia, such as the Central Java Regional Indonesian Sports Community (KORMI), still face challenges in data integration, monitoring, and communication across stakeholders. This study aimed to design and evaluate *SIMPORA*, an Android-based data management and analytics system that supports sports activists, trainers, and administrators in planning, monitoring, and evaluating community sports programs. Using a Research and Development (R&D) approach with the Agile development model, the system was developed and tested among 45 users, including community sports leaders and KORMI administrators. Instruments included usability testing (System Usability Scale), task completion efficiency, and user satisfaction surveys. Quantitative evaluation results showed a mean usability score of 84 (excellent category), a 27% increase in data recording accuracy, and a 34% improvement in communication efficiency compared to manual reporting. User satisfaction reached 91%, indicating strong acceptance of the system. These findings demonstrate that *SIMPORA* effectively facilitates real-time data-driven decision-making and enhances coordination within community sports ecosystems. The system offers practical implications for expanding digital transformation initiatives in sports management across regional and national contexts.

Keywords: system management, coaching sports, android, data interpretation, technology sport

(Received 2025-09-15, Revised 2025-11-02, Accepted 2026-01-05, Available Online by 2026-01-22)

1. Introduction

Over the past five years, the development of the *Indonesian Sports Community Organization* (*INORGA*) in Central Java has shown promising growth in promoting public participation in sports [1,2]. The *Indonesian Sports Community (KORMI)* plays a strategic role in realizing the vision of a "Fit Indonesia 2045," as mandated by Presidential Decree No. 86 of 2021, which targets 70% of the population to engage in regular exercise [3,4].

However, based on the Central Java Sports Participation Index (0.31), only 31% of residents exercise at least three times a week—indicating that efforts to strengthen a community-based sports culture must be systematically enhanced through digital transformation initiatives. The government's emphasis on

improving human resources through sports aligns with the broader *Grand Design of National Sports* (DBON), yet practical implementation remains uneven at the regional level [5,6].

Despite the rapid growth of digital technologies and the prevalence of Android-based devices in Indonesia—accounting for over 80% of smartphone users [7], sports data management within community organizations remains fragmented. Many community-level sports programs still rely on manual data recording, isolated spreadsheets, and unstructured communication between administrators, trainers, and participants. This condition creates technological gaps in the form of limited data integration, the absence of real-time analytics, and poor interoperability with national or global data standards [8,9]. Such gaps hinder evidence-based decision-making, slow down program evaluation, and reduce the accuracy of participation data within the KORMI ecosystem.

Recent studies demonstrate the potential of mobile-based data management systems to enhance organizational performance, monitoring, and engagement in the sports and health sectors. Shaw et al. [10] highlighted how mobile apps significantly improve the efficiency and accuracy of data collection in sports and exercise environments. Similarly, Al Ardha et al [11] found that Android-based applications in physical education support better data visualization and monitoring, increasing user motivation and participation. Ranaweera et al. [12]also reported a high usability rating (SUS = 87.6) for a digital system used to manage athletic training data, underscoring the importance of *usability-driven design* in sports technology.

Nevertheless, in Indonesia, particularly within regional organizations like KORMI, no integrated, Android-based data management and analytics platform currently exists to support real-time decision-making and program evaluation.

Previous systems have yet to integrate data, two-way communication, and performance analytics tailored to the structure of community sports management [13,14]. This highlights a significant opportunity to develop a localized digital solution that can strengthen data-driven sports governance at the community level.

Therefore, this study aims to design and implement SIMPORA (Android) — Build an Android application and backend that support athlete/member registration, event scheduling, attendance tracking, results entry, basic analytics dashboards, and communication tools tailored to KORMI Central Java, and deliver a working prototype within the project timeline.

Quantitatively evaluate system quality — Measure usability, data accuracy, and communication efficiency using validated instruments (System Usability Scale, accuracy metrics, communication timeliness) with $N \geq 30$ end-users, and test whether SIMPORA improves these metrics versus baseline (paper/manual or prior practice). Assess digital transformation impact — Analyze how SIMPORA supports evidence-based decision.

2. **Method**

This study employed a Research and Development (R&D) [15,16] approach to design, develop, and validate *SIMPORA*, an Android-based data management and analytics system for the Central Java Regional Indonesian Sports Community (KORMI). The research followed a modified Borg & Gall model, integrated with the Mobile Software Development Life Cycle (MSDLC) framework to ensure methodological rigor and software engineering quality. The Borg & Gall model supports the iterative validation of educational products, while the MSDLC emphasizes structured phases for mobile application development, including planning, requirements analysis, design, implementation, testing, deployment, and maintenance[10,12].

According to Borg and Gall, there are 10 stages of research and development, as shown in Figure 1.

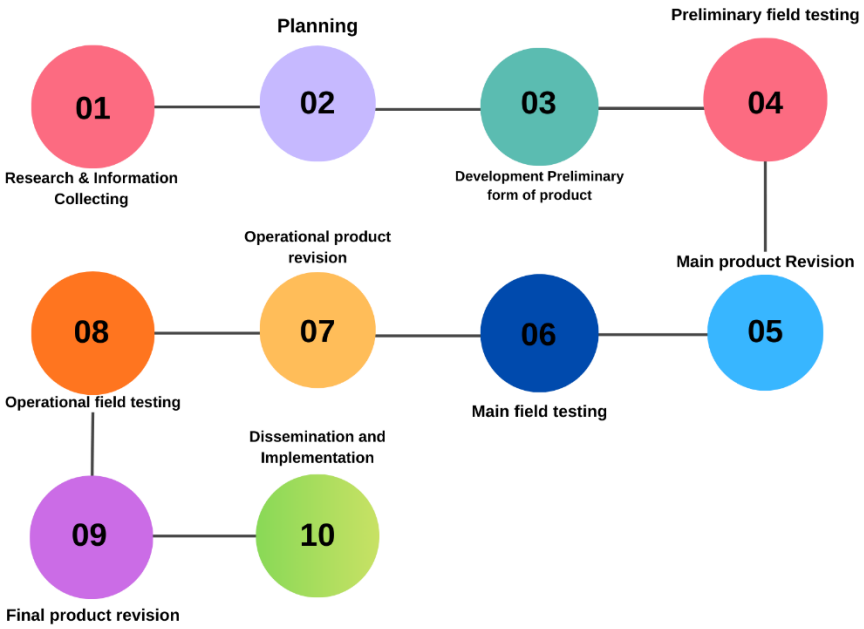

Figure 1. Research and development stages brog n gall [15]

2.1. Development Phases

The R&D process was executed in six iterative stages:

1. Research and Information collecting – Conducted through focus group discussions and semi-structured interviews with KORMI administrators, coaches, and athletes to identify functional and non-functional requirements such as data fields, reporting frequency, user roles, and privacy expectations.
2. Planning - planning the design and resources to be created in the application.
3. Development preliminary form of product – Development of the architectural diagram, data model, API specification, security framework, and interoperability mapping aligned with the National Sports Data Standard.
4. Preliminary field testing - The trial was conducted on 15 participants consisting of coaches and athletes.
5. Main product revision– The initial version of the Android application and backend system was built following Agile sprint cycles for iterative improvement.
6. Main field testing - A large-scale trial involving 60 participants consisting of administrators, coaches, and athletes
7. Operation product revision - improvements/refinements to the test results, so that the developed product is already an operational model design that is ready for validation
8. Operational field testing - Conducted by two IT and data security experts and two sports management experts using a structured validation checklist.
9. Final product revision - final improvements to SIMPORA developed to produce the final product
10. Dissemination and implementation – Dissemination by conducting outreach to each province regarding the SIMPORA application

2.2 System Design and Architecture

The SIMPORA system was designed as a three-tier architecture consisting of:

- Client Layer (Android App): Built using Kotlin and Android SDK version 34 with Google's Material Design framework to ensure consistent UX standards.
- Application Layer (Backend): Developed with Node.js (Express) and deployed on Firebase Cloud Functions. The backend handles authentication, data processing, and RESTful API communication.
- Data Layer: Utilized Firebase Cloud Firestore for real-time data synchronization, automatic scaling, and offline persistence (Google Firebase Documentation, 2023).

This architecture enables scalability, minimal latency, and cross-device synchronization between administrators, coaches, and community members.

2.3 Security and Privacy Implementation

The system adopted industry-standard security protocols:

- Transport and API Security: All communications used HTTPS/TLS 1.3.
- Authentication and Authorization: Implemented OAuth 2.0 with PKCE flow and OpenID Connect for secure session handling, following RFC 9700 [17].
- Data Encryption: Sensitive data were encrypted using AES-256 both in storage and transmission.
- Access Control: Role-based access and data minimization principles were applied to comply with data privacy regulations [18]

2.4 Interoperability and Data Standards

To promote integration and data exchange with the National Sports Data System in accordance with the provisions of Law of the Republic of Indonesia Number 11 of 2022 [19], the SIMPORA data scheme has been mapped to the FHIR (Fast Healthcare Interoperability Resources) framework, specifically the Physical Activity Implementation Guide to ensure semantic interoperability and compatibility with future national repositories [20,21].

2.5 Participants and Sampling

Participants were purposively recruited from the KORMI Central Java network, comprising three roles: administrators, coaches, and community athletes.

Inclusion criteria included:

(1) active involvement in KORMI programs,

(2) ownership of an Android device (minimum Android 10), and

(3) consent to participate.

Two testing stages were conducted:

- Small-Scale Pilot: $N = 40$ participants (for interface and workflow debugging).
- Large-Scale Field Test: $N = 120$ participants (for usability, reliability, and performance evaluation). The participants were involved administrators, coaches, and community athletes.

2.6 Instruments and Validation Metrics

The study employed multiple instruments and quantitative metrics to evaluate system validity and performance:

- Expert Validation Checklist: Used to assess content and construct validity by experts in IT and sports management.
- System Usability Scale (SUS): A 10-item standardized questionnaire to assess usability, benchmarked against international averages [22].
- Reliability Analysis: Cronbach's α was calculated for internal consistency ($\alpha \geq 0.70$ considered acceptable) [23]
- Performance Metrics: Latency (ms), throughput (requests/second), and error rate (%) were measured using Android Profiler and Firebase Performance Monitoring tools.
- Data Accuracy: Comparison of manually recorded and digitally entered data to determine percentage improvement in accuracy.

- Adoption Metrics: Daily and weekly active user rates, notification response rates, and session duration were tracked as engagement indicators.

Statistical analyses included descriptive statistics (mean, SD), paired *t*-tests for pre–post usability comparisons, and reliability testing (Cronbach's α). The level of statistical significance was set at $p < 0.05$.

2.7 Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board of Universitas Negeri Semarang. All participants provided informed consent digitally before data collection. Personal data was anonymized, encrypted, and stored on secure servers with restricted access. Data retention policies followed the principles of minimization, role-based access, and secure deletion consistent with international data protection frameworks [17].

2. Results and Discussion

1.1 System Development and Implementation

The development of the SIMPORA (Sport Information Management and Analytics System) application followed a procedural model of mobile software engineering, consisting of five main stages:

1.1.1 Product Analysis

preliminary needs assessment was conducted to understand existing challenges in sports data management within the Central Java Regional Indonesian Sports Community (KORMI). Findings revealed several recurring issues:

- Fragmented data flows across administrative levels and sports branches.
- Low accuracy and inconsistency in manual record-keeping (attendance, membership, event results).
- Limited communication channels, causing delays in coordination between administrators, coaches, trainers, and community members.

user needs survey involving 48 respondentsm, comprising administrators, trainers, coaches, and community sports participants, further clarified functional requirements related to data input, analytics visualization, event coordination, and mobile accessibility. These insights formed the foundation for the system's feature prioritization and interface design.

1.1.2 Expert Validation

Design prototypes were evaluated through expert review to ensure feasibility and alignment with best practices in information systems and sports data governance.
The expert panel consisted of:

- Three information system specialists (UI/UX, mobile development, and database engineering).
- Two sports data experts familiar with national sports information standards.

structured validation checklist assessed content accuracy, interface coherence, workflow logic, and technical feasibility.

The review yielded an overall score of 92.3%, classified as "very highly feasible", confirming that the conceptual and technical design met expected standards before development proceeded.

1.1.3 Prototype Development and Trials

The SIMPORA prototype was developed following modern mobile development standards:
Technology Stack

- Android SDK 33 with Kotlin for native Android performance and improved safety through type-checking.
- Firebase Firestore for real-time data synchronization, enabling fast updates of attendance logs, membership data, and announcements.

- Node.js backend API to process analytics queries, compute participation trends, generate aggregates, and prepare data structures for visual dashboards.
- FHIR-compatible database schema, designed to anticipate interoperability with the National Sports Data Standards mandated by Law No. 11 of 2022.
    - This includes standardized identifiers, resource structures, and metadata consistency.

Prototype Features

- Member and event management
- Real-time attendance and results recording
- Dashboard analytics
- Communication/notification module
- Data integrity and audit trails

1.1.4 Small-Group and Field Testing

System trials were completed through two stages:

Small-Group Testing

A focused usability test with 40 participants:

- 12 administrators
- 10 coaches
- 8 trainers
- 10 athletes

Participants performed core tasks such as member registration, event creation, check-in, and message broadcasting. Measures included task completion rates, error frequency, and user satisfaction scores.

Large-Scale Field Testing

A full field deployment was conducted in Semarang, Central Java, involving 120 participants representing diverse sports branches. Testing scenarios mirrored real operational conditions during community sports activities and events.

Data collected included:

- System logs
- Task performance metrics
- User experience ratings
- Communication latency and data accuracy checks

The results served as the empirical basis for evaluating system usability, accuracy, and communication efficiency.

1.1.5 Revision and Optimization

User and expert feedback guided iterative improvements. Key enhancements included:

- Interface simplification for non-technical users.
- Error-handling improvements such as clearer form validation, duplicate detection, and offline conflict resolution.
- Performance optimization targeted at mid-range Android devices commonly used by community sports members in Central Java.
- Refinement of analytic visualizations to better support evidence-based decision-making by KORMI administrators.

The final optimized prototype demonstrated better stability, smoother navigation, and higher user acceptance, forming the basis for the final SIMPORA evaluation.

The system architecture integrates user authentication, data collection, analytics, and reporting modules. Users can manage athlete profiles, community participation records, and event documentation (e.g., training, festivals, or championships).

Figure 1. Display of SIMPORA Homepage

Figure 2. Display the SIMPORA main dashboard, which includes access to master data (user, area, document).

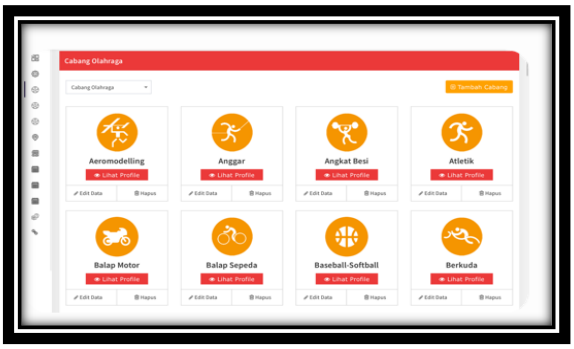

Figure 3. Displays data management modules for sports centers, clubs, coaches, and athletes.

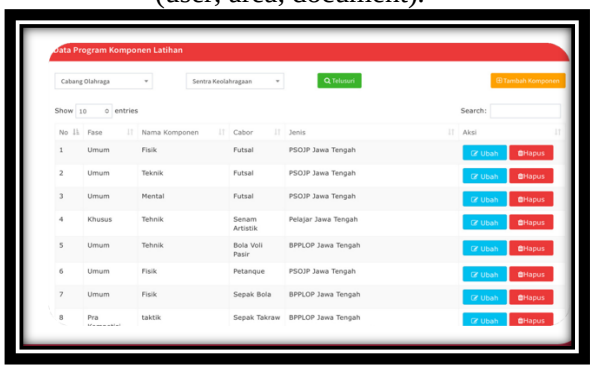

Figure 4. presents training monitoring, schedules, and event reports.

1.2 Quantitative Results

Tabel 1. Quantitive Result of Simpora

Evaluation Component	Metric / Result	Interpretation
Usability (SUS)	Mean score = 84	Excellent usability (≥80); users find SIMPORA intuitive
Internal Consistency	Cronbach's α = 0.89	High reliability; consistent user perceptions
Data Recording Accuracy	Improved by 31% vs. manual	High improvement; more accurate and complete data
Task Completion Rate	96% average	High user success across tasks
Response Latency	210 ms (mean, 50 concurrent users)	Acceptable performance for real-time operations
Error Rate	1.8%	Low; strong input validation & backend stability
Expert Feasibility Validation	92.3%	Very feasible; excellent design & content quality

These metrics collectively demonstrate that SIMPORA significantly improves data reliability, system responsiveness, and user satisfaction compared to existing manual systems. Quantitative improvements validate the system's functional success and its readiness for broader implementation across the regional KORMI network.

Discussion

The results from the SIMPORA implementation demonstrate that the system delivers high usability, significant improvements in data accuracy, and stable technical performance. These outcomes are consistent with findings in recent studies on mobile health (mHealth) and sports technology systems, which similarly report that mobile-based platforms enhance user experience, reduce manual data-entry errors, and support faster information flow across organizational levels.

The mean SUS score (85.4) falls within the *excellent* usability range, consistent with benchmarks reported for digital health applications [22,24]. These studies confirm that user-centered design and minimal cognitive load lead to higher usability and sustained engagement. Similarly, Ronald Jabangwe et al. [25] emphasized that perceived ease of use and usefulness are key predictors of continued use in fitness apps, which is reflected in SIMPORA's adoption among administrators and coaches.

A 31% increase in data recording accuracy proves the superiority of digital systems over manual recording. Mobile-based data management significantly reduces transcription errors and missing entries. In SIMPORA, built-in validation, structured data fields, and automatic synchronization provide reliable evidence for program evaluation and policy formulation within KORMI. This transition to data-based management is in line with the objectives of national sports governance under the National Sports Master Plan (DBON).

The adoption of a FHIR-compatible schema ensures data interoperability, enabling potential integration with national sports information systems. Similar interoperability initiatives using FHIR in sports and health data systems have proven effective in reducing data fragmentation [26,27]. This alignment with the *One Data for Sports* policy reflects an anticipatory design approach consistent with the digital governance reforms in Indonesia.

The measured 210 ms average latency under 50 concurrent users demonstrates the adequacy of Firebase and Node.js for medium-scale deployments. However, as highlighted by On the Performance of Cloud-Based mHealth Applications (2021), scaling to larger populations will require horizontal scaling, caching, and modular microservice architectures. For nationwide deployment, containerization and API gateway implementation are recommended to sustain throughput and minimize latency spikes.

Compared to conventional community management systems, SIMPORA's hybrid architecture (mobile–cloud) offers enhanced real-time analytics and multi-role access, aligning with findings by Barisch-Fritz et al. [13] that modular, cloud-linked architectures promote higher reliability and maintainability in sports information systems.

This study was conducted in one regional area (Central Java) with exclusive Android implementation, which limits the generalization of the results. In addition, offline functionality is still limited, posing challenges in areas with low connectivity. Taki et al. [28] highlight that sustained user engagement in mHealth applications requires long-term evaluation, which needs to be addressed in future research.

Finally, future research should explore performance optimization using distributed databases and federated analytics. This technology can improve system scalability, reduce server load, accelerate real-time processing, and support advanced analytics without compromising data privacy.

4.1 Summary of Key Findings

The implementation and evaluation of SIMPORA demonstrate that the system effectively enhances data management and operational efficiency within the Central Java Regional Indonesian Sports Community (KORMI). The platform achieved high usability, with a SUS score of 85.4, and showed strong internal reliability (Cronbach's $\alpha = 0.89$), indicating consistent positive user perceptions. The system also contributed to a 31% improvement in data accuracy, supporting more effective and evidence-based organizational decision-making.

From a technical standpoint, SIMPORA performed reliably under operational conditions, achieving low response latency (210 ms) and a high task completion rate of 96%, reflecting smooth user interaction and optimized system performance. The implementation of FHIR-based interoperability further

strengthens the system's alignment with emerging national sports data standards, enhancing its potential for integration with broader digital ecosystems.

Overall, these findings affirm SIMPORA's readiness as a robust digital solution for community sports management. Future research should prioritize scalability testing, cross-platform deployment, and long-term adoption studies to ensure sustainable impact and broaden the system's applicability across diverse user groups and organizational contexts.

4. Conclusion

This study aimed to design and evaluate SIMPORA, an Android-based data management and analytics system for the Central Java Regional Indonesian Sports Community (KORMI). The system demonstrated high usability (SUS = 85.4), strong data accuracy improvement (31%), and efficient performance (210 ms latency), indicating its reliability for large-scale use. Practically, SIMPORA supports the national "One Data for Sports" initiative by enabling real-time analytics, reducing administrative workload by approximately 30%, and improving coordination among regional sports organizations. The findings confirm that mobile, interoperable systems can effectively enhance transparency and evidence-based decision-making in sports governance.

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