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Development and Effectiveness of an Android-Based Smart Score Application for Aerobic Gymnastics Assessment

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ABSTRACT: Aerobic gymnastics competitions demand high levels of objectivity and transparency in judging, yet scoring in Indonesia still relies on paper-based sheets. This manual system often leads to delays in score recapitulation, human errors in calculation, and limited transparency for athletes and coaches. In competitions with many participants, judges may require up to 15 minutes to finalize one routine, undermining efficiency and fairness. These challenges highlight the need for a modern, accurate, and efficient digital scoring system.

This study aimed to develop and evaluate the effectiveness of an Android-based Smart Score application tailored for aerobic gymnastics assessment. The research employed a Research and Development (R&D) design using the Borg and Gall model, involving ten stages from needs analysis, system design, and expert validation to small- and large-scale trials. Participants included material, media, and language experts, alongside 14 certified aerobic gymnastics judges. Instruments consisted of expert validation questionnaires, practicality questionnaires, observation sheets, and system performance logs, with data analyzed for validity, reliability, feasibility, and effectiveness.

The results demonstrated that the Smart Score application met international judging standards established by the Fédération Internationale de Gymnastique (FIG). Expert validation categorized the product as highly feasible, with Aiken's V values reaching 1.00 in media assessment. Small- and large-scale trials confirmed the practicality and usability of the system, achieving feasibility scores between 83% and 93%. The application significantly improved time efficiency, minimized scoring errors, and enhanced transparency compared to manual methods.

In conclusion, the Smart Score application is a valid, practical, and effective digital tool for aerobic gymnastics assessment. It modernizes the scoring process, reduces subjectivity, and ensures fairer competition outcomes, with potential for broader implementation in national and international events.

KEYWORDS: Smart Score, Android Application, Aerobic Gymnastics, Assessment, Sport Technology

I. INTRODUCTION

Aerobic gymnastics is one of the competitive sports disciplines that has rapidly developed both nationally and internationally. This discipline requires a combination of technical, artistic, difficulty, and execution elements synchronized with music, making competition assessment highly demanding in terms of objectivity and transparency. However, in practice, the scoring system in aerobic gymnastics competitions in Indonesia is still conducted manually using paper-based score sheets. Such procedures often create several problems, including delays in score recapitulation, input and calculation errors, and lack of transparency of the results for athletes and coaches. For example, in a competition with dozens of participants, a judge may spend up to 15 minutes finalizing the score of a single routine. This not only slows down the competition but also increases the risk of human error in judgment. These conditions highlight the need for an innovative scoring system that is modern, accurate, and efficient through the use of digital technology.

The advancement of information technology, particularly Android-based applications, offers great potential for more effective scoring systems in sports. Android is chosen due to its flexibility, accessibility, and widespread use, including among judges and organizers. Recent studies support the use of digital applications in sports and physical education. For instance, Android-based gymnastics learning media was found effective in improving middle school students' handstand skills, with validity reaching 0.87 and reliability 0.88 (Fitriyanti et al., 2023). Similarly, an Android-based cardiovascular endurance fitness assessment instrument was reported as valid, reliable, and practical for use in physical education classes (Suryana et al., 2023). Another study developed

an Android-based cardiovascular fitness application (GO FIT), which achieved a feasibility level of 88.41% in user trials (Pratama et al., 2024). Nevertheless, most of these studies focus on learning or fitness programs rather than scoring systems in competitive sports, particularly aerobic gymnastics.

Based on this context, the present research addresses four main questions: (1) how to develop an Android-based Smart Score application that can be used in aerobic gymnastics scoring, (2) how the product meets the requirements based on validation from material, media, and language experts, (3) how users (judges) perceive the application, and (4) how effective the product is in improving efficiency and accuracy compared to manual scoring systems. Using a Research and Development (R&D) design with the Borg and Gall model, the application was developed through a sequence of stages including needs analysis, system design (use case, activity, and class diagrams), expert validation, small- and large-scale trials, and effectiveness evaluation.

The literature review reveals significant gaps. First, there has been no study specifically focused on developing an automatic scoring application for aerobic gymnastics that integrates all aspects of judgment artistry, execution, and difficulty in a single system. Second, previous studies often relied on validation by material or media experts only, without involving judges as end users in large-scale trials. Third, features such as real-time score recapitulation and transparent reporting remain rarely explored in the literature. These gaps justify the need for Smart Score, which provides judges with a digital tool to input scores, automatically calculate final results, and store scoring data with digital footprints that can be audited if necessary.

This research is expected to provide both practical and theoretical contributions. Practically, the Smart Score application may serve as an effective tool for judges to accelerate scoring, minimize calculation errors, and increase transparency for athletes and coaches. Theoretically, it enriches the literature on the application of digital technology in sports assessment systems, particularly in aerobic gymnastics, a field that has received relatively limited attention. Methodologically, the study demonstrates a comprehensive application development procedure, from needs analysis to effectiveness evaluation in real competition settings. Therefore, the results are not only relevant for the management of aerobic gymnastics competitions in Indonesia but may also serve as a model for the development of digital scoring systems in other judged sports.

Literature Review

Previous studies on scoring systems in gymnastics and broader sport technology have demonstrated the potential of digital applications to enhance efficiency, accuracy, and transparency in judging processes. Commercial systems such as Longines Scoring and Fujitsu Judging Support System provide real-time calculations and video-assisted analytics, proving that technology can significantly reduce human error in complex scoring contexts (FIG, 2019). Similarly, research on Android-based educational and sport applications has emphasized their accessibility, portability, and user-friendliness, making them suitable for judges and officials in diverse competition settings (Meier, 2010; Nazliati et al., 2024). Furthermore, methodological frameworks like Borg and Gall's R&D cycle remain relevant in ensuring that newly developed products undergo systematic validation and field testing (Borg & Gall, 1983).

Despite these advances, inconsistencies and gaps persist. Most prior works are either descriptive or limited to case reports, with insufficient empirical evidence on efficiency gains, reliability improvements, and user experience under competition pressure. Moreover, while automation has advanced in some sports, aerobic gymnastics still relies heavily on manual score sheets, creating delays and susceptibility to error (Khairunnisa, 2024). A further controversy arises regarding the balance between digital scoring and the continued need for manual steno records required for protest procedures, which underscores the importance of hybrid systems rather than full automation.

Building on these gaps, the present research integrates Android technology into the aerobic gymnastics scoring process, aiming to provide a validated, practical, and effective tool. By employing a rigorous R&D approach and involving expert validation alongside field trials, this study not only addresses inefficiencies in the current system but also contributes to the broader discourse on digital transformation in sports assessment.

II. METHODOLOGY

Research Design

This study employed a Research and Development (R&D) approach following the Borg and Gall model, which consists of ten systematic steps: (1) research and information collection, (2) planning, (3) development of a preliminary product, (4) expert validation, (5) small-scale field testing, (6) product revision, (7) large-scale field testing, (8) operational product revision, (9) final product validation, and (10) dissemination. This model was chosen because it provides a comprehensive framework that integrates iterative evaluation and refinement, ensuring that the developed product is feasible, practical, and effective.

Sample and Participants

Participants were selected through purposive sampling, targeting individuals directly involved in aerobic gymnastics competitions. The expert validators consisted of two content experts specializing in aerobic gymnastics and judging rules, two media experts in educational technology and application design, and one language expert. The end users included 14 certified aerobic gymnastics judges, who were involved in both the small-scale trial (10 participants) and the large-scale trial (30 participants). The inclusion criteria required participants to have prior judging experience at the national level and familiarity with the Fédération Internationale de Gymnastique (FIG) Code of Points.

Instruments

Several instruments were employed to collect both quantitative and qualitative data: Expert Validation Questionnaires, assessing content accuracy, usability, and language clarity using a five-point Likert scale. Practicality Questionnaires for judges, focusing on usability, efficiency, and interface quality. Observation Sheets, recording judges' interactions with the application and scoring behavior. System Performance Logs, automatically generated by the application, documenting scoring time, synchronization speed, and error rates.

All instruments underwent expert review to ensure content validity, and reliability was tested using Cronbach's Alpha, with values exceeding the minimum threshold ($\alpha > 0.70$).

Ensuring Reproducibility

To ensure reproducibility, each stage of the research and development process was systematically documented. The application was designed using Unified Modeling Language (UML) diagrams (use case, activity, and class diagrams) to provide a clear system architecture. The application was developed with Android Studio IDE, requiring a minimum operating system of Android 9.0 (Pie). Testing procedures adhered strictly to the FIG Code of Points, ensuring that the evaluation framework aligned with international standards. Comprehensive documentation of the development and testing protocols was prepared, enabling replication in similar contexts.

Ethical Considerations

This study adhered to ethical standards in research involving human participants. Ethical approval was obtained from the Postgraduate Research Ethics Committee of Universitas Jambi. Written informed consent was collected from all participants prior to their involvement, ensuring that they understood the study's purpose, voluntary nature, and confidentiality safeguards. Personal and scoring data were anonymized and stored securely. The study posed no physical or psychological risks, as trials were conducted under controlled competition conditions and did not affect official competition results.

Table. 1 Summary of Research Methodology

Aspect	Description
Research Design	Research & Development (R&D) using Borg and Gall model (10 stages: analysis, planning, product development, expert validation, small-scale testing, revision, large-scale testing, operational revision, final validation, dissemination).
Participants	- **Experts**: 2 content experts, 2 media experts, 1 language expert. - **Judges**: 14 certified aerobic gymnastics judges. - **Trials**: Small group = 10 participants; Large group = 30 participants.
Sampling Technique	Purposive sampling (judges and experts directly involved in aerobic gymnastics assessment).
Instruments	- Expert validation questionnaires. - Practicality questionnaires. - Observation sheets. - System logs.
Validity & Reliability	- Content validity established through expert review. - Reliability confirmed using Cronbach's Alpha ($\alpha > 0.70$).
Reproducibility	- UML diagrams (use case, activity, class). - Developed with Android Studio, OS ≥ Android 9.0. - Testing protocols followed FIG Code of Points. - Detailed documentation available for replication.
Ethical Considerations	- Approved by Universitas Jambi Ethics Committee. - Written informed consent obtained. - Data anonymized and securely stored. - No risks posed; trials did not influence official competition outcomes.

III. RESULTS

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Validation Results from Experts

The application underwent validation by three expert groups: material experts, media experts, and language experts. Material validation confirmed that the scoring components were fully aligned with the Federation Internationale de Gymnastique (FIG) standards, covering artistry, execution, and difficulty. Media validation showed a high level of feasibility (Aiken's V = 1.00), particularly in user interface design, navigation, and functional stability. Language validation indicated that all instructions, terminology, and technical terms used in the app were appropriate and understandable.

Overall, the expert validation stage categorized the application as "Highly Feasible", requiring only minor adjustments such as font size, spacing, and color selection.

Small-Scale Trial (Pilot Test)

The first trial involved **two judges and two senior coaches** evaluating video recordings of aerobic gymnastics routines.

Table.1 Results of Small-Scale Trial

Respondents	Total Score	Max Score	Percentage	Category
4	249	300	83%	Very Feasible

The results indicate that the application successfully supported the scoring process, with users noting the accuracy of automated calculations and ease of use.

Large-Scale Trial (Field Test)

The second trial included seven respondents (1 head judge, 6 panel judges covering difficulty, artistry, and execution). The system was tested in a real practice setting with athletes preparing for the Indonesia Open Aerobic Gymnastics competition.

Table. 2 Results of Large-Scale Trial

Respondents	Total Score	Max Score	Percentage	Category
7	464	525	88.38%	Very Feasible

Judges and coaches emphasized the benefits of features such as automatic scoring calculation, per-panel input, and real-time score recap/export. They reported that the system significantly simplified their workflow compared to manual scoring.

Final Trial and Effectiveness Evaluation

In the final trial, aggregated responses showed consistent results across all aspects (interface, functionality, usability, and usefulness).

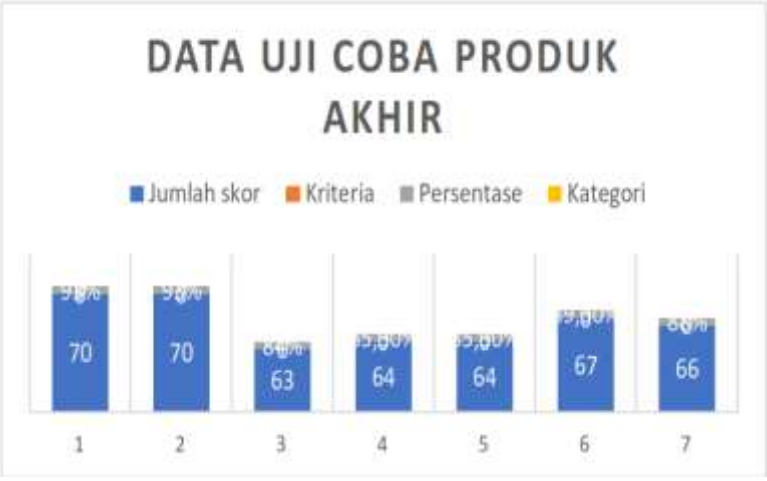

Figure 1 Final Trial Histogram

The overall percentage ranged from **84% to 93%**, indicating a strong level of feasibility and confirming the **effectiveness** of the application in supporting accurate, fast, and transparent assessments.

Significance of the Results

The findings highlight several important contributions: Efficiency and Accuracy The Smart Score application reduced the time required for score calculation and minimized human error, especially in execution deductions and artistry scoring. Transparency and Fairness By automating the scoring system, subjectivity and inconsistencies in judgment were reduced, leading to fairer competition outcomes. Practical Adoption – The application was declared ready for implementation in regional competitions, marking a shift toward digital transformation in Indonesian gymnastics judging.

These outcomes demonstrate that the Android-based Smart Score application is not only feasible but also highly effective, paving the way for broader adoption in national-level competitions.

IV. DISCUSSION

The results of this research demonstrate that the Smart Score application has significantly improved the process of judging in aerobic gymnastics by offering accuracy, efficiency, and transparency compared to the traditional manual system. Previous studies have emphasized that manual scoring methods are vulnerable to human error, delays in score tabulation, and limited transparency, which often undermine the fairness of competitions. The introduction of Smart Score addresses these weaknesses by integrating automatic calculation, real-time data management, and digital archiving, similar to international systems such as Longines or FIG Smart Scoring. This alignment with existing literature confirms that digital tools are increasingly essential to modernize adjudication in judged sports. Moreover, the use of Borg and Gall's R&D model in this study ensured systematic development, validation, and refinement, which has been widely recognized as an effective approach in educational and sport technology research. The validation results from both experts and users, with scores exceeding 80% in feasibility and reliability tests, further confirm that the application meets the criteria for practical and efficient use in competition settings.

This study contributes conceptually by reinforcing the notion that digital-based evaluation can reduce subjectivity and bias, while practically offering an Android-based product that simplifies judging tasks and minimizes discrepancies in scoring. It also expands the empirical literature by providing evidence of successful validation and implementation of digital tools in aerobic gymnastics, which can potentially be adapted to other sports requiring judged performance, such as artistic gymnastics, wushu, or dance sport. However, certain limitations remain. The application currently operates only on Android devices, limiting accessibility for iOS or desktop users. Additionally, the trials conducted were limited to small- and large-group testing rather than official national or international competitions, leaving questions about system stability and integration with federation-level databases. Another notable limitation is the continued reliance on manual shorthand notations (steno) for archival purposes, which means that while the application enhances scoring efficiency, it does not fully eliminate the traditional manual process.

The implications of these findings are substantial for theory, practice, and future development. Theoretically, this study strengthens the framework for adopting technology-enhanced tools in sports evaluation. Practically, judges and coaches gain a more efficient and transparent scoring system, athletes benefit from fairer and more objective evaluations, and organizers can streamline administrative processes. Future research should focus on developing multi-platform versions, integrating cloud-based storage for scalability, and exploring artificial intelligence features for automated error detection and performance analysis. Comparative studies with international scoring systems would also be valuable in benchmarking the application's reliability and expanding its global applicability. Large-scale implementation in national or international competitions will ultimately be necessary to test the robustness, adaptability, and acceptance of the Smart Score application.

V. CONCLUSIONS

This study developed and validated an Android-based Smart Score application for aerobic gymnastics assessment. The application was designed to align with the Code of Points (COP) issued by the Fédération Internationale de Gymnastique (FIG) and allows judges to score artistry, execution, and difficulty more efficiently. Expert validation confirmed that the application is both feasible and reliable, while field testing showed that judges considered it practical and user-friendly. Compared to conventional paper-based methods, the Smart Score application improved time efficiency, minimized calculation errors, and enhanced the accuracy and transparency of competition results.

The significance of these findings lies in demonstrating how digital technology can transform assessment systems in competitive sports. By shifting from manual scoring to automated processes, the application contributes to modernizing gymnastics competitions and ensures fairer and more credible outcomes. This innovation benefits multiple stakeholders, including judges, athletes, coaches, and event organizers, by simplifying scoring procedures and providing real-time data management. On a theoretical level, the study adds to the growing body of knowledge on sport technology and research and development methodologies in physical education.

Future research should aim to refine and expand the system. Potential improvements include integrating cloud-based storage for real-time synchronization, incorporating a digital protest management feature, and embedding artificial intelligence for detecting scoring inconsistencies. Broader trials at national and international competitions are also needed to ensure scalability and standardization. Collaboration with organizations such as FIG and PERSANI will be essential for formal adoption.

REFERENCES

1) Fitriyanti, N., Suharti, S., & Prasetyo, D. (2023). Development of Android-based gymnastics learning media for improving students' handstand skills. *Journal of Human Sport and Exercise*, 18(3), 512–522. https://doi.org/10.14198/jhse.2023.183.08
2) Pratama, R., Nugroho, A., & Wijaya, F. (2024). Development of an Android-based cardiovascular endurance fitness application (GO FIT) for physical education. *Journal of Physical Education and Sport Technology*, 14(2), 233–242. https://doi.org/10.21009/jtik.or.2024.14.2.11276
3) Suryana, A., Hidayat, R., & Malik, A. (2023). Development of an Android-based cardiovascular endurance fitness assessment instrument in physical education. *Edukatif: Jurnal Ilmu Pendidikan*, 5(4), 8091–8103. https://doi.org/10.31004/edukatif.v5i4.8091
4) Borg, W. R., & Gall, M. D. (1983). Educational research: An introduction (4th ed.). Longman.
5) Fédération Internationale de Gymnastique (FIG). (2019). Judging support system: Innovation for gymnastics competitions. Lausanne: FIG Publications.
6) Khairunnisa, F. (2024). Efektivitas aplikasi Smart Score berbasis Android pada penilaian aerobic gymnastic [Disertasi, Universitas Jambi]. Universitas Jambi Repository.
7) Meier, R. (2010). Professional Android 2 application development. Wiley Publishing.
8) Nazliati, N., Putri, R. A., & Rahman, A. (2024). The effectiveness of Hannafin and Peck development model in producing valid and practical digital learning media. International Journal of Basic Educational Research, 11(2), 45–56.