

The Implementation of Digital Score Sheet to Increase the Efficiency of Match Evaluations by Tennis Referees

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Abstract

The rapid development of information technology in sports has encouraged the digitalization of competition management systems, including the process of score recording by referees. In tennis competitions, score recording is still commonly conducted manually using paper-based score sheets, which are often inefficient, prone to data loss, and difficult to monitor in real time by stakeholders. This study aimed to implement and evaluate the use of an Android-based digital score sheet application, Dik_Tennis Score, to support tennis referees in Central Java in preparation for the Pre-Regional Sports Week (Pra-PORPROV) and the XVII PORPROV events in 2025/2026. The research employed a training-based implementation approach involving tutorials, demonstrations, hands-on practice, and monitoring and evaluation of referees' ability to operate the application. Participants included regional, national, and white-badge tennis referees who were actively involved in officiating tennis competitions in Central Java. The findings revealed that most referees had previously relied on manual score recording and had limited experience with digital systems. After participating in the training and practical sessions, approximately 80% of the referees were able to independently operate the Dik_Tennis Score application to record match events and transmit results online. The implementation of this digital system improves the efficiency of match administration, facilitates real-time monitoring of match scores, and enables systematic storage of competition data through a web-based database. Therefore, the adoption of an Android-based digital score sheet application has significant potential to enhance the quality of tennis match officiating and support the broader digital transformation of sports competition management.

Keywords: digital score sheet, tennis referees, sports technology, android application

INTRODUCTION

The integration of digital technology in sports management has increased significantly in the last decade. Various technological innovations have been developed to support athlete performance analysis, event management, and refereeing systems. In modern sports competitions, digital systems are increasingly used to improve efficiency, accuracy, and transparency in match administration. In tennis, referees play a crucial role in ensuring fair play and maintaining the integrity of the game. One of the most important administrative tasks of referees is recording match events through a score sheet, which documents player identity, match format, and the sequence of points during the match (1,2).

However, in many regional and national tournaments, particularly in developing countries, tennis referees still rely on paper-based score sheets. This manual system often causes several operational challenges. The process of recording scores manually requires considerable time, increases the risk of human error, and makes it difficult to store match data systematically. Moreover, paper-based records limit the ability of organizers and spectators to monitor match results in real time (3,4). In the era of digital transformation and big data in sports, such limitations reduce the effectiveness of match management and hinder the development of modern sports information systems.

Recent studies have highlighted the increasing role of technology in sports officiating and event management. Chen explains that artificial intelligence and digital systems are increasingly used in sports refereeing to improve decision accuracy and data recording efficiency (5). Similarly, Byun, Chiu, and Bae emphasize that mobile applications and digital platforms have become important tools for sports management because they enable real-time information exchange and enhance communication among

stakeholders (6,7). Other studies have shown that smartphone-based technologies can improve operational efficiency in sports contexts, particularly when integrated with web-based databases and monitoring systems (8,9).

The use of Android-based applications has also attracted attention in sports technology research. Leong and Wong demonstrated that smartphone-based systems can provide reliable and accurate performance monitoring tools for sports activities (10). In addition, Sulaksono developed an Android-based augmented reality application for tennis learning, indicating that mobile technology has strong potential to support various aspects of tennis development, including training and competition management (11). These findings confirm that smartphone technology offers practical solutions for sports applications because it is widely accessible and easy to integrate with online data systems.

Another important aspect of digital sports systems is the use of big data and online databases to store match records. Li argues that big data systems allow sports organizations to collect, store, and analyze large volumes of competition data, which can be used for performance evaluation and event management improvement (12–14). Likewise, Fan and colleagues highlight that web-based data systems can improve data accessibility and facilitate the integration of multiple data sources in digital platforms (15). In the context of sports competitions, such systems can provide real-time match information for organizers, coaches, athletes, and spectators.

Despite these technological advancements, the adoption of digital score sheet systems in tennis competitions remains limited, particularly in regional tournaments. Many referees still rely on manual documentation methods due to the lack of accessible digital tools and training. This situation creates several operational issues, such as delayed match reporting, incomplete match records, and difficulties in storing historical match data. In addition, spectators and stakeholders often face challenges in accessing match results when competitions are held in different venues. These limitations indicate a significant gap between technological development and its practical implementation in sports officiating.

To address these challenges, this study introduces and evaluates an Android-based digital score sheet application called Dik_Tennis Score, designed to assist tennis referees in recording match events efficiently and transmitting match results in real time. The application integrates smartphone-based score recording with a web-based database system that allows match results to be monitored online and stored as part of a centralized data repository. This digital system aims to simplify the score recording process, improve data accuracy, and support transparent match administration.

The novelty of this study lies in the integration of a mobile-based refereeing application with an online match monitoring system specifically designed for tennis competitions at the regional level. Unlike previous studies that focused primarily on athlete performance monitoring or training technologies, this research emphasizes the digital transformation of match officiating systems. By providing a practical and accessible technological solution, the study contributes to the development of sports technology in refereeing systems and supports the modernization of tennis competition management.

Furthermore, the implementation of digital score sheet technology also aligns with global trends in sustainable and paperless sports event management. Reducing paper usage in competition administration supports environmental sustainability and promotes more efficient data management practices. Therefore, the adoption of digital score sheet systems not only improves operational efficiency but also contributes to broader technological and sustainability goals in sports management.

Based on these considerations, the present study aims to implement and evaluate the effectiveness of the Dik_Tennis Score digital score sheet application for tennis referees in Central Java as preparation for the Pre-PORPROV and the XVII PORPROV events in 2025/2026. The study focuses on examining how the application improves referees' efficiency, facilitates real-time match reporting, and enhances the management of competition data. Ultimately, this research seeks to provide empirical evidence on the potential of digital technology to improve refereeing systems and support the digital transformation of sports competitions.

METHOD

Research Design

This study employed a descriptive implementation-based research approach to examine the application of the Dik_Tennis Score digital score sheet system for tennis referees. The descriptive approach was chosen because the research aimed to systematically describe the process of implementing digital technology in sports officiating and to evaluate its effectiveness in improving match administration. Implementation-based studies are widely used in sports technology research to assess how digital applications or information systems are adopted and utilized in real sporting environments. Such approaches allow researchers to evaluate the usability, practicality, and operational benefits of digital tools in sports

management contexts.

Research Location and Participants

The study was conducted in Central Java, Indonesia, during training and simulation sessions organized to prepare tennis referees for the BK-PORPROV and the XVII PORPROV competitions scheduled for 2025–2026. These regional multi-sport events require accurate and efficient match administration systems, including reliable score recording methods.

The participants consisted of tennis referees at regional, national, and white-badge levels who were actively involved in officiating tennis competitions in Central Java. Participants were selected using purposive sampling, which involves selecting respondents who have relevant experience and expertise related to the research topic. In this case, referees were chosen because they directly perform match score recording and therefore represent the most relevant users of the digital score sheet system.

Data Collection Methods

Data were collected using three main techniques: observation, questionnaires, and documentation.

Observation

Observation was conducted to examine how referees recorded match scores before and after the introduction of the digital score sheet system. This process allowed the researchers to identify changes in operational efficiency, recording accuracy, and ease of use when referees utilized the Dik_Tennis Score application compared with traditional paper-based score sheets. Observational methods are commonly applied in sports technology research to analyze the practical implementation of digital systems within sports activities and competitions.

Questionnaire

The questionnaire is used to measure referees' perceptions of the ease of use, effectiveness, and benefits of the Dik_Tennis Score application in supporting refereeing tasks. The questionnaire instrument is arranged using a Likert scale to assess several aspects such as ease of use, speed of score entry, accuracy of match data, and user satisfaction with the digital system.

Documentation

Documentation was used to collect supporting data related to the research process. These data included match records generated through the application, screenshots of application usage, training materials, and reports from the training sessions. Documentation helps strengthen research validity by providing evidence of how the digital system was implemented and utilized.

Data Analysis

The collected data were analyzed using descriptive quantitative and qualitative analysis techniques.

Quantitative data obtained from questionnaires were analyzed using descriptive statistics, including percentages and mean scores, to evaluate referees' responses regarding the usability and effectiveness of the application. This analysis provided an overview of the level of acceptance and perceived usefulness of the digital score sheet system among referees.

Qualitative data obtained from observations and documentation were analyzed through data reduction, categorization, and interpretation. These steps allowed the researchers to identify patterns related to improvements in the match score recording process after the adoption of the digital application. The integration of quantitative and qualitative data analysis is commonly applied in sports technology studies to provide a comprehensive evaluation of digital systems used in sports management and officiating.

Research Limitations

This study has several limitations. First, the number of participants was limited to tennis referees in one province, which may restrict the generalizability of the findings to other regions or sports contexts. Second, the evaluation of the application was conducted primarily during training and simulation sessions rather than during a large number of official matches. Future research could expand the scope by involving referees from different regions and by examining the long-term use of digital score sheet systems in official tournaments.

RESULTS AND DISCUSSION

This section presents the findings of the study regarding the implementation and evaluation of the

Dik_Tennis Score application as a digital score sheet system for tennis referees. The analysis focuses on several key aspects, including the characteristics of the research participants, referees' perceptions of the application, and the effectiveness of the digital system in supporting match score recording and competition data management. The research data were obtained through observations, questionnaires, and documentation conducted during the training and simulation sessions of the application involving tennis referees in Central Java. The findings are analyzed using a descriptive approach to provide an overview of user acceptance, system usability, and the benefits of the application in improving efficiency, accuracy, and transparency in tennis match administration. Furthermore, the discussion compares the results of this study with previous research related to the use of digital technology in sports officiating systems and sports competition management.

Characteristics of Research Participants (Tennis Referees)

Table 1. Characteristics of Research Participants (Tennis Referees)

		Tennis Referees		
		Referee Certification Level	Number of Participants	Percentage
Number	1	Regional Referee	15	50%
	2	National Referee	10	33%
	3	White Badge Referee	5	17%
	Total		30%	100%

Sources: Authors, 2026

The participants consisted of 30 tennis referees with different certification levels. Most participants were regional referees, followed by national referees and white-badge referees. This distribution reflects the diversity of refereeing experience involved in the training and evaluation of the digital score sheet system.:

Referees' Perceptions of the Dik_Tennis Score Application

Table 2. Referees' Perceptions of the Dik_Tennis Score Application

		Referees' Perceptions		
		Evaluation Indicator	Mean Score (1–5)	Category
Number	1	Ease of use of the application	4.45	Very Good
	2	Speed of score recording	4.32	Very Good
	3	Accuracy of match data	4.38	Very Good
	4	Helpfulness in refereeing tasks	4.40	Very Good
	5	Overall user satisfaction	4.36	Very Good
		Average Score	4.38	Very Good

Sources: Authors, 2026

The results indicate that referees generally had a positive perception of the application. The highest score was found in the **ease-of-use indicator**, suggesting that the system interface was intuitive and accessible for referees. Overall, the average score of 4.38 shows that the digital score sheet system was perceived as highly effective in supporting refereeing activities.

Comparison Between Manual and Digital Score Recording

Table 3. Comparison Between Manual and Digital Score Recording

		Comparison
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		Aspect	Manual Score Sheet	Dik_Tennis Score Application
Number	1	Score recording time	Longer	Faster
	2	Risk of calculation errors	Higher	Lower (automatic scoring system)
	3	Data storage	Paper archive	Digital database
	4	Match result reporting	Delayed	Real-time
	5	Data accessibility	Limited	Accessible online

Sources: Authors, 2026

The comparison shows that the digital system provides several advantages compared with the traditional paper-based score sheet system. The most significant improvements were observed in data accessibility and reporting speed, as match results could be transmitted instantly through the web-based monitoring system.

System Effectiveness Based on Referees' Responses

Table 4. System Effectiveness Based on Referees' Responses

		System Effectiveness		
		Category	Number of Referees	Percentage
Number	1	Very Effective	18	60%
	2	Effective	9	30%
	3	Moderately Effective	3	10%
	4	Less Effective	0	0%
	5	Ineffective	0	0%

Sources: Authors, 2026

Most referees (90%) evaluated the digital score sheet system as effective or very **effective** in assisting match administration. Only a small proportion of referees considered the system moderately effective, mainly due to technical issues such as internet connectivity.

Implementation of the Digital Score Sheet System

The implementation of the Dik_Tennis Score digital score sheet application was carried out through a training and simulation program involving tennis referees in Central Java. The program introduced referees to the use of an Android-based application designed to replace conventional paper score sheets. During the training sessions, referees were guided through several stages, including application installation, player data input, match score recording, and real-time result submission through a web-based system.

The results indicate that most referees initially relied on manual score sheets during tennis competitions. Paper-based documentation was perceived as familiar but inefficient, especially in tournaments with multiple matches running simultaneously. After the training and practical sessions, referees were able to operate the digital system effectively. Approximately 80% of participants demonstrated the ability to record match scores independently using the application, while the remaining participants required additional guidance during the early stages of use.

These findings show that the adoption of mobile-based digital systems can be implemented relatively quickly when users receive proper training. The system significantly simplified the administrative process of match recording, particularly in the automatic generation and storage of match data.

Efficiency and Accuracy of Match Score Recording

One of the main advantages observed during the implementation process was the improvement in efficiency and accuracy of score recording. Using the digital application, referees were able to input match scores more quickly compared with the manual recording process. The application also minimized the risk of calculation errors because the system automatically processed point progression according to tennis scoring rules.

In conventional paper-based score sheets, referees must manually calculate points, games, and sets. This process often leads to errors, particularly during intense matches where referees must simultaneously observe gameplay and record results. In contrast, the digital system integrates scoring logic into the application interface, allowing referees to focus more on monitoring the match while the system assists in score calculation.

The findings support previous studies that highlight the benefits of digital technologies in sports officiating. (16) explains that digital systems and artificial intelligence technologies can improve the accuracy of decision-making and data recording in sports competitions. Similarly, (17) found that digital tools can support referees' cognitive processes by reducing administrative workload during match supervision.

Real-Time Match Monitoring and Data Management

Another important outcome of this study is the ability of the system to transmit match results in real time through a web-based platform. Once a referee records the final score in the application, the result is automatically uploaded to the system database. This feature allows tournament organizers to monitor match results across different courts simultaneously.

The availability of real-time data significantly improves tournament management. Organizers can track match progress, update competition brackets, and communicate results to stakeholders more efficiently. In addition, match data are stored in a centralized database, which enables systematic documentation of competition records.

This result aligns with research by (18), who emphasize that digital information systems play an important role in the digital transformation of sports management. Big data systems allow sports organizations to collect and analyze competition data more effectively, which supports strategic decision-making and performance evaluation.

Compared with traditional score sheets that are often archived manually, digital data storage provides long-term advantages. Historical match records can be accessed quickly, and the data can be used for future competition analysis or athlete performance evaluation.

User Acceptance and Practical Benefits

The evaluation of referees' responses to the application indicates that most participants perceived the system as easy to use and beneficial for officiating tasks. The user-friendly interface allowed referees to quickly understand the operational functions of the application. In addition, the use of smartphones made the system accessible because most referees were already familiar with mobile devices.

These findings are consistent with technology adoption studies in sports contexts. (7) explain that mobile applications have become important tools in sports management because they enable efficient communication and information exchange among stakeholders. (8) demonstrate that smartphone-based technologies can provide reliable and accessible digital tools for sports-related activities.

However, several referees initially expressed concerns regarding internet connectivity and device compatibility during competition events. These technical aspects highlight the importance of infrastructure support when implementing digital systems in sports competitions, particularly in regional tournaments where technological facilities may vary.

Research Contribution and Comparison with Previous Studies

The findings of this study contribute to the development of sports technology in refereeing systems, particularly in tennis competitions. Previous studies have mainly focused on the use of digital technology for athlete performance analysis, training systems, or video-based referee assistance technologies. For example, (19) developed an AI-based referee assistance system to support decision-making in sports competitions.

In contrast, the present study focuses on administrative digitalization in sports officiating, specifically the transformation of manual score recording into a mobile-based digital system integrated with an online monitoring platform. This focus represents an important contribution because administrative efficiency is a crucial component of effective sports event management.

Moreover, the implementation of a digital score sheet system at the regional tournament level demonstrates that technological innovation in sports management does not always require complex or expensive systems. Simple mobile applications can provide practical solutions that improve transparency, efficiency, and data management in sports competitions.

Implications for Sports Event Management

The results suggest that the adoption of digital score sheet systems has significant potential to improve sports event management. The integration of mobile technology and web-based databases supports faster match reporting, better data organization, and improved communication among stakeholders.

In addition to operational benefits, the digital system also supports paperless administration, which aligns with global trends toward sustainable event management. Reducing paper usage in match administration not only simplifies data storage but also contributes to environmentally responsible sports management practices.

Overall, the implementation of the Dik_Tennis Score application demonstrates that digital transformation in sports officiating systems can enhance the quality and efficiency of match administration. The system provides a practical technological solution that supports referees, tournament organizers, and other stakeholders involved in tennis competitions.

CONCLUSION

His study aimed to implement and evaluate the effectiveness of the Dik_Tennis Score digital score sheet application as a tool to support tennis referees in recording match events and managing competition data. The findings demonstrate that the integration of a mobile-based digital score sheet system can significantly improve the efficiency and accuracy of match score recording compared with traditional paper-based methods. The application enables referees to record scores more quickly, reduces the risk of calculation errors, and facilitates the automatic storage of match data within a centralized digital database.

Another important contribution of this study is the ability of the system to provide real-time match reporting through a web-based platform, allowing tournament organizers and stakeholders to monitor competition progress more effectively. The positive responses from referees indicate that the application is user-friendly and can be adopted with relatively short training sessions. These findings suggest that digital technologies have strong potential to modernize refereeing systems and improve the overall management of tennis competitions.

From a practical perspective, the implementation of digital score sheet systems can support transparent, efficient, and paperless sports event management, which aligns with global trends in sports digitalization and sustainable event administration. The system can be applied not only in regional tournaments but also in larger competitions that require faster match reporting and systematic data management.

However, further development is recommended to enhance the scalability and reliability of the system. Future studies may expand the implementation of digital refereeing systems across different regions and sports disciplines, as well as integrate additional features such as automated statistics, match analytics, and cloud-based competition management platforms. Through continuous technological development and wider adoption, digital score sheet systems can become an essential component of modern sports management and officiating practices.

ACKNOWLEDGMENTS

The authors would like to express their sincere appreciation and gratitude to all parties who have provided support in the implementation of this research. First, the authors would like to thank the **Central Java Provincial Board of the Indonesian Tennis Association (PELTI)** for providing the opportunity and support in organizing training activities and implementing the **Dik_Tennis Score** application for tennis referees as part of the preparation for the **BK-PORPROV and the XVII PORPROV events in 2025/2026**. The authors also extend their gratitude to all **tennis referees in Central Java** who participated as respondents in this study and provided valuable feedback regarding the use of the digital score sheet system in tennis competitions. Their active participation greatly contributed to the evaluation of the effectiveness of the developed application. The authors also acknowledge the contributions of the **Dik_Tennis Score development team** who played an important role in the development and refinement of the system so that it could be used in training and match simulation activities. In addition, the authors appreciate the support from various parties who assisted in the implementation of the training sessions, data collection, and research documentation. Finally, the authors would like to thank all individuals who cannot be mentioned individually for their moral and technical support, which made this research possible. The collaboration and support from these parties have been essential in supporting the development of digital technology aimed at improving the quality of tennis officiating systems and competition management.

DECLARATION OF CONFLICTING INTERESTS

The authors declare that there are no conflicts of interest related to this research, authorship, and publication of this article. This study was conducted independently without any commercial or financial relationships that could be construed as a potential conflict of interest. All parties involved in this research

contributed solely for academic and scientific purposes.

FUNDING

This research was supported by Universitas Negeri Semarang through the DIPA funding of Universitas Negeri Semarang. The funding was used to support training activities on the use of the Dik_Tennis Score application, data collection processes, and the implementation of match simulation sessions. The funding provided did not influence the research design, data analysis process, or the interpretation of the research results.

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