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Bridge Scorekeeping Automation: An iOS Application to Improve Tournament Scoring Accuracy and Efficiency

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Abstract

Scoring in bridge tournaments is still largely dominated by traditional methods such as manual score sheets and specialized devices like Bridgemate. While widely used, these approaches present significant limitations—manual scorekeeping is prone to human error, and Bridgemate devices are often costly and not accessible to all organizers. To address these challenges, Bridge Team Comparator was developed as an iOS-based application offering a more accurate, efficient, and affordable scoring solution for bridge tournaments. Designed with a user-friendly interface for both novice and experienced players, the application supports real-time score entry, automatic calculation of International Match Points (IMP), and efficient result summaries. The development process adopted the Challenge-Based Learning (CBL) framework through the phases of Engage, Investigate, and Act, focusing on simplifying the bridge scoring process. User testing involved bridge athletes from Universitas Negeri Malang, Universitas Brawijaya, and the Sidoarjo bridge community. Results demonstrated a reduction in scoring errors by 8–36% and increased efficiency compared to conventional methods. In addition to offering a cost-effective alternative to commercial devices, the application contributes to the digital transformation of scoring systems in traditional sports. With potential for cross-platform development, Bridge Team Comparator opens new opportunities for broader adoption within the global bridge community.

Keywords: *bridge card game, challenge-based learning (CBL), bridge team comparator, scoring, ios application*

1 Introduction

Bridge is a cognitive sport that emphasizes strategic partnership and has a long-standing history, playing a significant role in sports diplomacy. The game was introduced in Indonesia by the Dutch in the late 1800s and has been officially regulated by the Indonesian Bridge Federation (GABSI) since 1953. GABSI later joined the Indonesian National Sports Committee (KONI) and has actively participated in sending athletes to numerous national and international championships, including multi-sport events such as PON, SEA Games, and Asian Games. Indonesia has successfully hosted several prestigious bridge tournaments, including the Far East Bridge Federation Championship in 1970 and the 41st World Bridge Teams Championship in 2013[1].

Bridge is a strategy card game for four players, organized into two linked teams: "North-South" and "East-West". The principal aim is to obtain the requisite number of tricks to satisfy the declared contract. Each participant receives 13 cards from a standard deck, and the game is divided into three principal phases: bidding, playing, and scoring. Scoring in bridge is based on the quantity of tricks secured by the declarer's team in alignment with the contract. Additional points or penalties may be applied depending on factors such as contract duplication and vulnerability status. In competitive bridge, performance differences between pairs are measured using International Match Points (IMP), with the pair accumulating the highest IMP being declared the winner [2].

Duplicate Bridge follows a standardized scoring system as outlined in Law 77, which governs the trick score based on contract type (♣, ♦, ♥, ♠, or No-Trump). No-Trump contracts have distinct values, and a single-board score of 100 points or more is classified as a Game, while a score below this threshold is designated as a Partscore. Additional bonuses are awarded for Small Slams (500-750 points) and Big Slams (1,000-1,500 points), depending on vulnerability status. Overtricks earn players

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extra points, while penalties for undertricks vary based on vulnerability conditions and whether the contract was doubled or redoubled [3].

Law 78 outlines various scoring methodologies used in Duplicate Bridge tournaments, including Matchpoint Scoring, which compares players' scores; International Matchpoint (IMP) Scoring, which translates point differentials into IMP; and Total Point Scoring, which sums all points accumulated across played boards. These regulations establish tournament conditions, including scoring methods, winner selection criteria, and tiebreak protocols, ensuring fairness and consistency[3].

Currently, bridge tournaments utilize two primary scoring methods: manual score sheets[4] and electronic scoring devices such as Bridgemate[5]. Bridgemate II is the latest device designed for bridge scorekeeping, featuring an enhanced interface and software capabilities. It offers a high-contrast LCD screen, customizable function buttons, and a durable yet lightweight structure. The device also boasts a removable, easy-to-clean cover and an extended battery life, lasting approximately 500 sessions with two AA batteries. Additionally, Bridgemate II provides a movement guide displaying player names and next-round details, streamlining the score input process. However, despite its advantages, Bridgemate II is costly, priced at €120 per unit and €190 for the wireless server[5], making it impractical for many bridge clubs and sports organizations with limited budgets. For example, in Malinau Regency, the PERPANI sports division receives an allocated budget of Rp 100 million, with a 15-20% deduction[6], further restricting the feasibility of acquiring such devices.

Despite the presence of electronic scoring solutions, many bridge tournaments, such as the XVIII Pomnas Kalimantan Selatan 2023, continue to rely on manual score sheets. In this system, the North-South pair records scores while the East-West pair verifies and signs them [4]. However, this method is prone to human error, inconsistencies, and discrepancies in scoring, which can impact match outcomes. Similar scoring challenges have been observed in other sports, such as amateur boxing[7], where subjective judgments have sparked controversy. To mitigate such issues, automated scoring systems utilizing machine learning models like M-LSTM and S-LSTM have been developed, significantly improving accuracy over traditional methods [7]. For instance, video-based and AI-driven systems have been implemented in figure skating to objectively evaluate technical elements and musical interpretation, reducing bias and human errors in scoring [8]. A comparable approach has been applied in amateur boxing to eliminate subjective biases, ensuring objectivity and reducing the risk of score manipulation [7].

In comparison, the research methodologies used in amateur boxing [7] and figure skating scoring automation[8] differ significantly from those in bridge scorekeeping. The automated boxing scoring system relies on wearable sensors embedded in gloves and protective gear to detect impact forces, transmitting data via Bluetooth to a ringside computer for real-time scoring. This method enhances objectivity but still faces challenges in distinguishing legitimate strikes from incidental contacts [7]. On the other hand, figure skating scoring employs deep learning-based video analysis, utilizing Self-Attentive LSTM and Multi-scale Convolutional Skip LSTM models to evaluate technical and artistic performances. While AI-based approaches improve fairness, they remain limited by dataset biases and evolving competition rules [8]. In contrast, bridge scorekeeping automation does not require complex sensors or AI-driven interpretation but instead focuses on accurately digitizing fixed rule-based calculations. Within the Challenge-Based Learning (CBL) framework, bridge scorekeeping can serve as a highly engaging, challenge-driven project where students actively collaborate, experiment, and innovate to develop efficient and accurate digital solutions for replacing manual scoring methods. By incorporating CBL, the automation of bridge scoring can become an opportunity for students to tackle authentic challenges through technology-driven innovations, ensuring accuracy while maintaining the integrity of the game. Despite the growing adoption of automated scoring in various sports, no existing research has specifically addressed the automation of bridge scoring. This gap highlights the need for an accessible, cost-effective, and accurate digital scoring solution tailored for bridge tournaments. Leveraging the strong engagement factor of CBL, researcher can be empowered to explore novel approaches, fostering creativity and real-world impact in the domain of bridge scorekeeping automation.

The objective of this research is to develop a smart and cost-efficient bridge scoring application that offers a more intelligent alternative to manual score sheets[4] and expensive electronic devices like Bridgemate [5]. This application aims to enhance accessibility, minimize human errors, and provide real-time scoring updates, making it an ideal solution for both amateur and professional

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bridge players. By streamlining the scoring process, this application contributes to the modernization of bridge tournaments, improving efficiency, accuracy, and overall user experience without incurring significant expenses.

2 Literature Review

Research on the automation of scoring systems in sports has advanced significantly, utilizing technologies such as computer vision and deep learning. Recent studies demonstrate how AI-based systems enhance scoring accuracy, improve efficiency, and reduce human bias across various sports disciplines. Xu et al. [8] created a deep learning system for assessing figure skating performances with Self-Attentive LSTM and Multi-scale Convolutional Skip LSTM models. Their study highlights how combining these architectures enables a more objective assessment of technical elements and artistic components compared to traditional human-judged methods. However, the primary challenge remains in adapting the system to different competition standards [8]. In combat sports, Quinn & Corcoran [9] demonstrated that a YOLOv5-based model can detect and classify athlete movements in real-time, assigning scores based on predefined competition rules. The study underlines the necessity for a more extensive and diverse dataset to improve model accuracy in handling complex motion variations [9]. Similarly, in strategy-based games such as chess, Wölflein & Arandjelović [10] combined computer vision and convolutional neural networks (CNNs) to detect chessboard positions with an error rate of just 0.23% per square—an improvement 28 times greater than previous methods. However, a major limitation of this study is the lack of a standardized public dataset for broader validation and testing under more diverse real-world conditions [10].

For card games like Bridge, Tian et al. [11] introduced Joint Policy Search (JPS) to enhance coordination in imperfect information games, using International Match Points (IMP) as a performance metric. Their findings showed an increase of +0.63 IMPs per board compared to previous baselines, outperforming the world champion Bridge software, WBridge5. However, the study was limited to the bidding phase and did not evaluate the play phase[11]. In ranking systems, Edelkamp [12] modified the Elo rating system to better accommodate card games like Skat, where luck plays a significant role. The proposed system balances skill and luck by factoring in card distribution probabilities and opponent strength, offering a more stable and accurate ranking system than traditional methods. However, a key limitation of this study is the need for further validation across various gameplay scenarios and the potential bias in the parameters used to adjust for the influence of luck[12].

Technological advancements in sports science have driven innovations in scoring automation. Sangwan et al. [13] highlighted how wearable devices, biomechanical analysis, and real-time monitoring improve athlete performance and data-driven decision-making. However, challenges such as over-reliance on technology and unequal access to advanced tools remain significant concerns[13]. The application of smart media in traditional sports was explored by Tang Yunhao [14], demonstrating how digitalization supports the preservation and development of ethnic sports. While smart media technology enhances promotion and documentation, issues related to accessibility gaps and the absence of standardized regulations pose major implementation challenges[14].

Challenge-Based Learning (CBL) is an increasingly popular methodology in technological solution development, particularly in project-based education. Perna et al. [15]examined the growing adoption of CBL in STEM education, emphasizing its ability to engage students in real-world problem-solving. However, resistance to change from educators and the difficulty of objectively assessing learning outcomes remain challenges[15]. Ward [16] integrated CBL, Education for Sustainable Development (ESD), and Student as Partners (SAP) into participatory learning modules, showing increased student engagement and greater flexibility in assessment methods. However, the study lacked real-world stakeholder involvement, limiting its applicability beyond academic settings[16].

Previous research has demonstrated how AI-driven technologies, including computer vision, deep learning, and automated scoring systems, have improved scoring accuracy across various sports. However, in the context of card games like Bridge, existing studies primarily focus on bidding strategy rather than a comprehensive automated scoring system. This research addresses that gap by developing the Bridge Team Comparator application, providing an accurate and cost-effective solution for automated scoring compared to manual methods and expensive devices like Bridgemate. Utilizing a Challenge-Based Learning (CBL) approach, this application enhances scoring efficiency in Bridge tournaments, reduces human error, and improves user experience, making it a modern alternative to traditional scoring methods.

3 Research Method

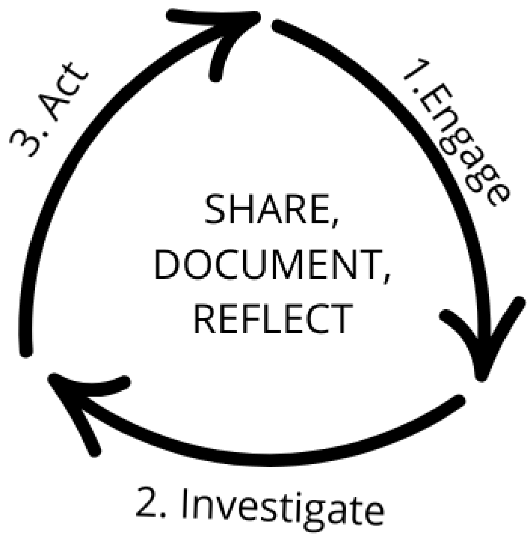

Figure 1. Challenge-based learning framework[17]

Challenge-Based Learning (CBL) in Figure 1 is a learning approach where students collaborate in groups to tackle open-ended and complex projects based on a broad STEM knowledge foundation. The challenges in CBL reflect the core practices of STEM professionals or pedagogically simplified versions. This concept connects learning to relevant social issues, helping students develop a positive STEM identity[18]. Challenge-Based Learning (CBL) is a collaborative educational paradigm that originated from the Apple Classrooms of Tomorrow—Today (ACOT2) initiative in 2008 and has been embraced by other universities, including ECIU. CBL consists of three main phases: **Engage, Investigate,** and **Act**, which are iteratively interconnected [19].

3.1 Engage

The Engage phase in Challenge-Based Learning (CBL) is a crucial initial step in designing solutions for real-world challenges. This process consists of four key elements: team formation, defining the Big Idea, formulating essential questions, and creating the challenge. Effective team formation, ideally with diverse backgrounds, ensures a broad range of perspectives for problem-solving. The Big Idea helps direct focus toward significant societal or environmental issues. Through essential questioning, students refine the Big Idea into a single actionable question. Finally, this question is developed into a concrete, measurable, and real-world challenge. The success of the Engage phase depends on active student participation, sufficient academic guidance, and collaboration with external stakeholders. If executed effectively, this phase ensures a smoother learning process and leads to impactful and well-developed solutions phase [19].

3.2 Investigate

The Investigate phase is a crucial stage in Challenge-Based Learning, where students conduct in-depth research to develop actionable and sustainable solutions for their identified challenge. This phase involves three key steps: formulating guiding questions, identifying guiding resources and activities, and conducting analysis. Students begin by developing guiding questions that help them explore their challenge in greater depth. In contrast to the Engage phase, which necessitates a singular critical question, this phase promotes the formulation of several inquiries to broaden the field of study,

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students utilize guiding resources and activities. Finally, in the analysis stage, students synthesize and summarize their findings, transcribe interviews, and create visual representations of data [19].

3.3 Act

The Act phase is where students refine, implement, and evaluate their solutions based on research, ensuring they are evidence-based and actionable. Solutions are tested through prototyping, problem-solving techniques, and stakeholder feedback. Implementation involves presenting findings to a real audience for validation, with guidance from teachers and CBL practitioners. This phase ends with evaluation and reflection, promoting critical thinking, teamwork, and the ability to solve real-world problems. By sharing their work, students gain recognition and motivation, ensuring that learning leads to meaningful impact [19].

4 Results and Analysis

The development process for the Bridge Team Comparator application followed the Challenge Learning Framework steps. Each step guided the project towards a user-centered solution for bridge team scorekeeping on iOS

4.1 Engage

In the Engage phase, the focus was to define the core challenge and align it with practical goals:

a) Team Forming: while Challenge-Based Learning encourages collaboration, this project was conducted individually to maintain a streamlined workflow and focus on a user-centered solution.

b) Big Idea: Simplifying bridge score calculations on iOS.

c) Essential Question: How can I help someone calculate bridge team competition results on iOS?

d) Challenge: Create a bridge scorekeeping tool for iOS that is accessible, efficient, and user-friendly.

4.2 Investigate

The Investigate phase was focused on research, exploring user needs, and identifying technical requirements

a) Guiding Questions and Guiding Resources:
   - Who will use the app?

   Answer : Bridge athletes involved in team matches who require real-time, accurate scoring.
   - What are the required inputs and outputs?

   Answer : Based on Bridgemate requirements, inputs include board numbers, contract details for each board, and results. And output will display board scores, IMPs for each team.
   - When is scoring needed?

   Answer: Scoring is completed after the playing phase, incorporating factors like the number of tricks won, contract bids, and vulnerability conditions that influence scoring and penalties.

b) Synthesis: The Investigate phase clarified that the Bridge Team Comparator must meet professional scoring standards while adapting to Duplicate Bridge methods. The app needs to support post-game scoring with IMP, adjusted, and total points calculations, emphasizing ease of use and accuracy for bridge players.

4.3 Act

Act phase involved designing, prototyping, and testing the solution based on the insights gathered.

a) Conducting Research and Developing a Solution: Based on the research, the app was designed to automate bridge scoring, reducing errors, and offer a cost-effective alternative to traditional scoring devices like Bridgemate. The app's interface aims to be accessible to both novice and experienced scorekeepers, simplifying bridge score management. To ensure a structured development process, several system design elements were created:

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1) Use Case Diagram, Figure 2 illustrates various interactions among components of an application to be developed[20].

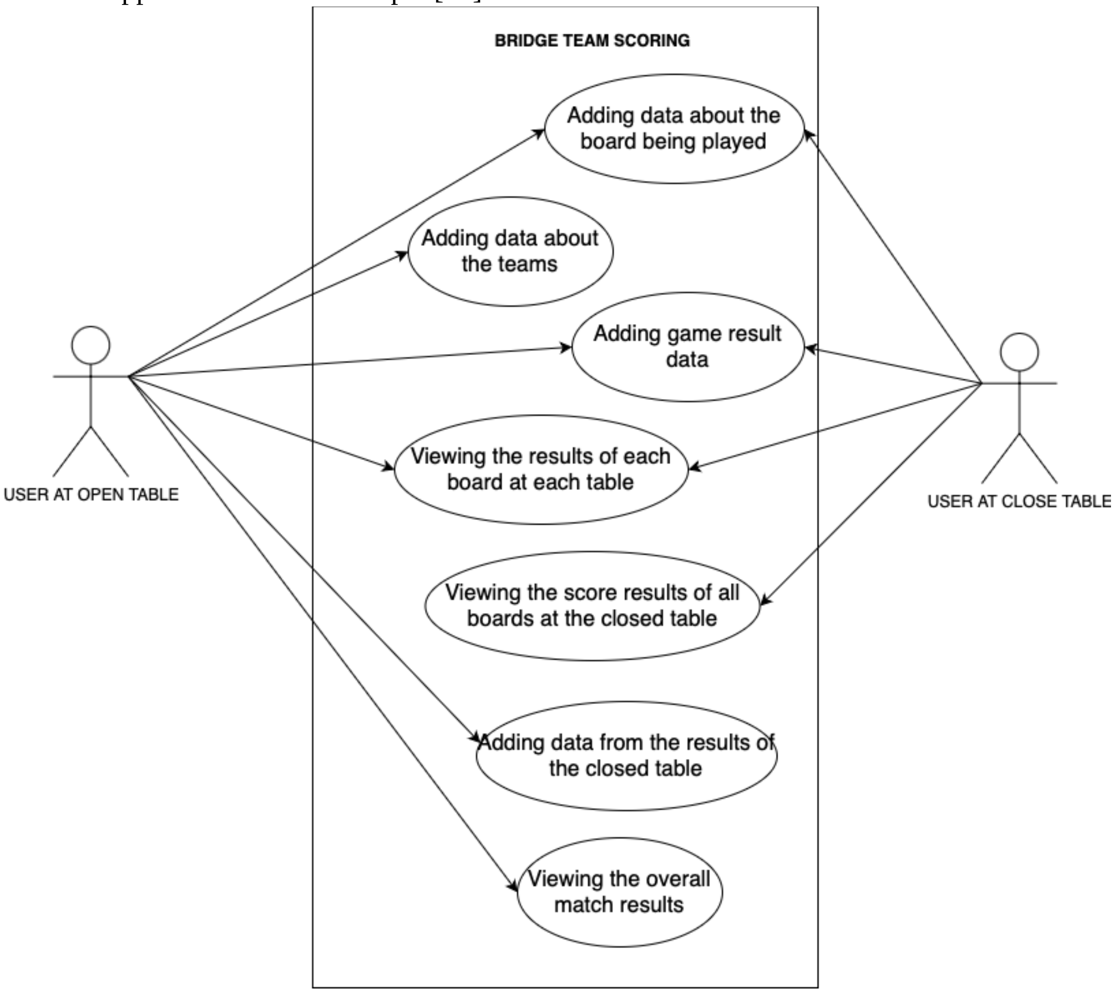

Figure 2. Use case diagram

2) Application Architecture, Figure 3 outlines how the user input the data, the application processes it, and then generates output back to the user.

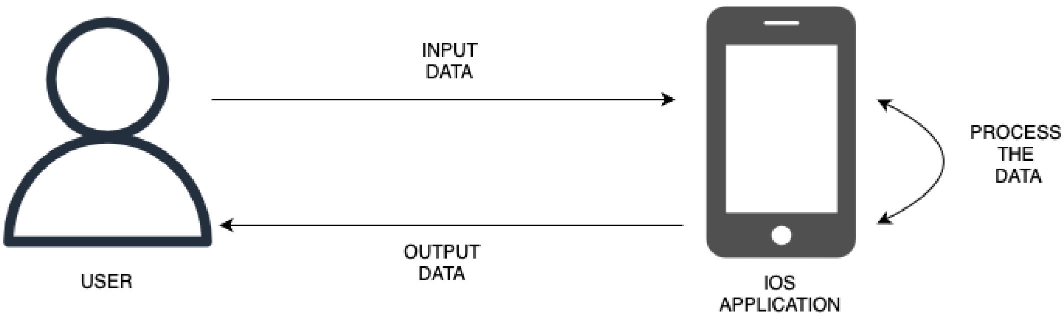

Figure 3. Application architecture

3) Activity Diagram, Figure 4 and Figure 5 delineates the process or activities within a system[20]. Figure 4 illustrates the activity diagram for users at an open table, while Figure 5 presents the activity diagram for users at a close table.

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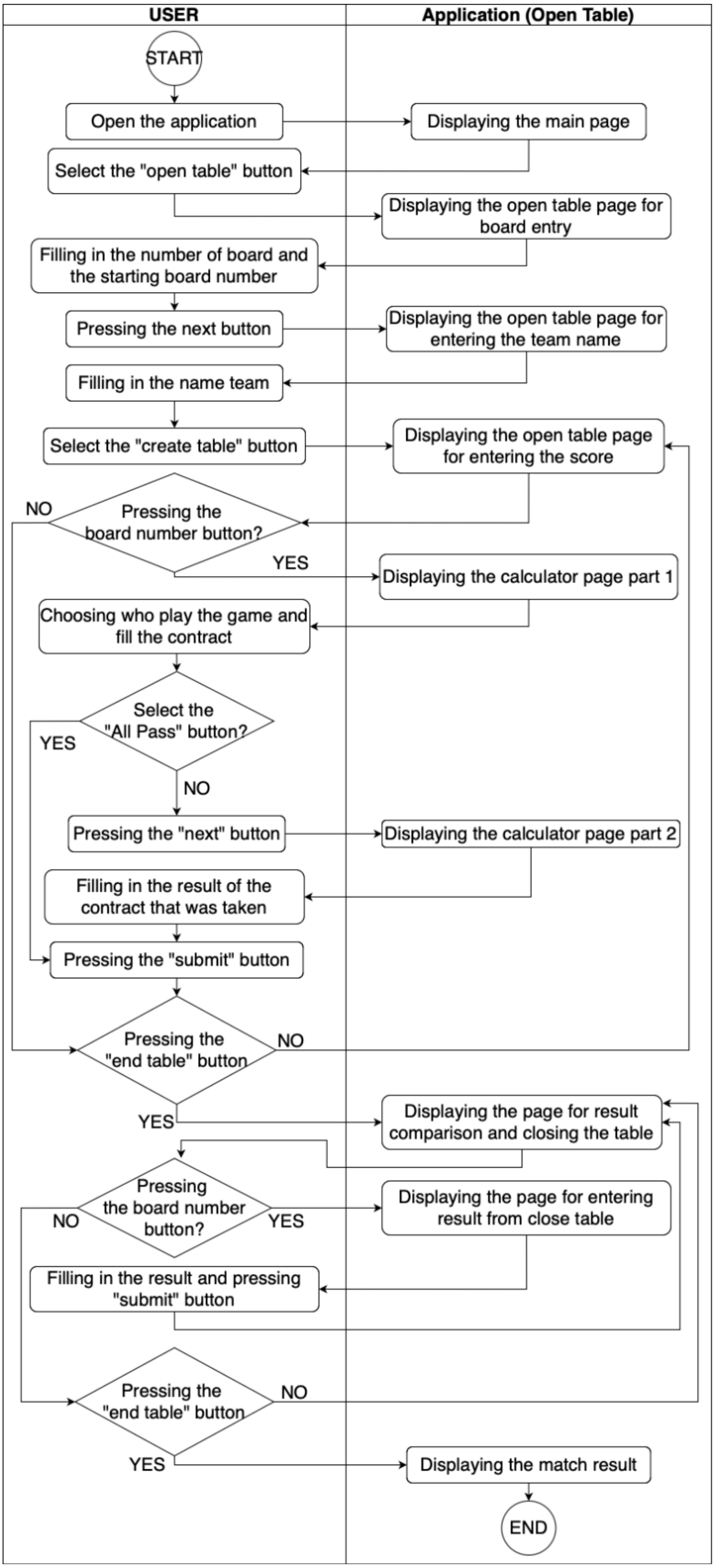

Figure 4. Activity diagram: open table

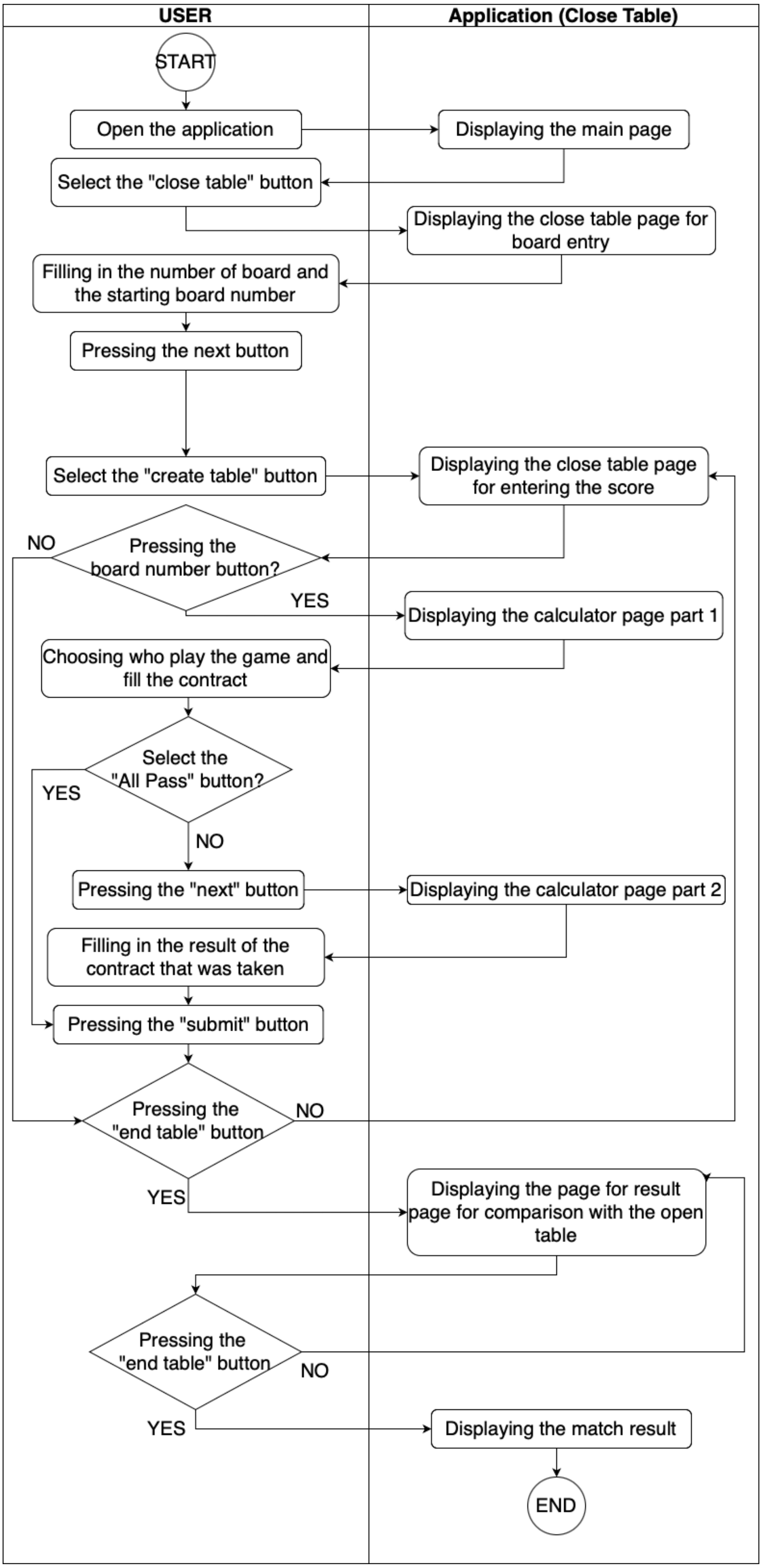

Figure 5. Activity diagram: close table

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4) User Interface. The user interface consists of several key screens designed to enhance usability and streamline the scoring process. The Home Page in Figure 6 allows users to select their table (e.g., Open or Closed), serving as the main navigation hub. The Data Input Page in Figure 7 enables users to input board numbers and team names, specifically for the Open Table setup. To facilitate the recording of match results, the Score Submission Page in Figure 8 provides an interface for users to enter and submit scores efficiently. The Scoring Page in Figure 9 is designed to assist users in entering contract results and calculating scores per board with precision. Additionally, the Comparison Page in Figure 10 enables the transfer of results from the Closed Table to the Open Table, ensuring accurate data synchronization. Finally, the Result Page in Figure 11 presents the final game results in a structured and easy-to-read format, summarizing the match outcomes effectively.

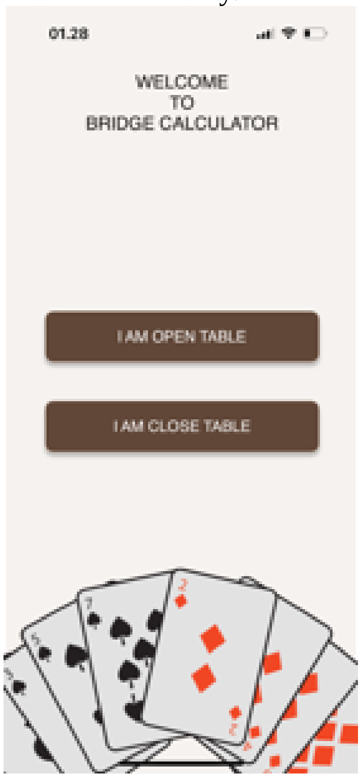

Figure 6. Home page: allows users to select their table (e.g., open or closed)

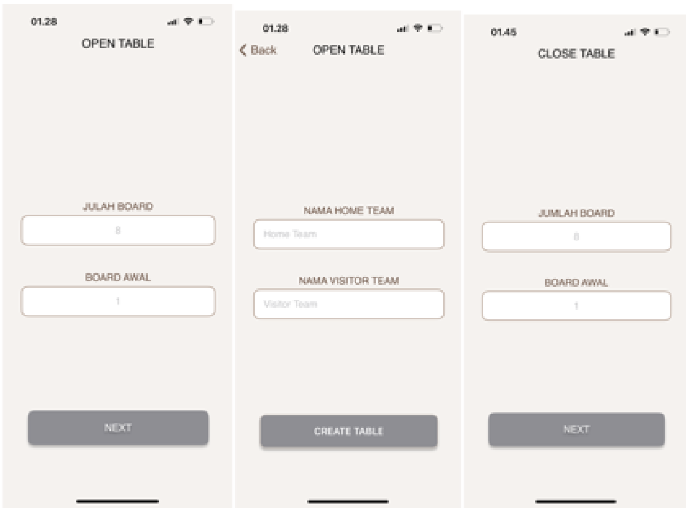

Figure 7. Data input page: users can input board numbers and team names (open table only)

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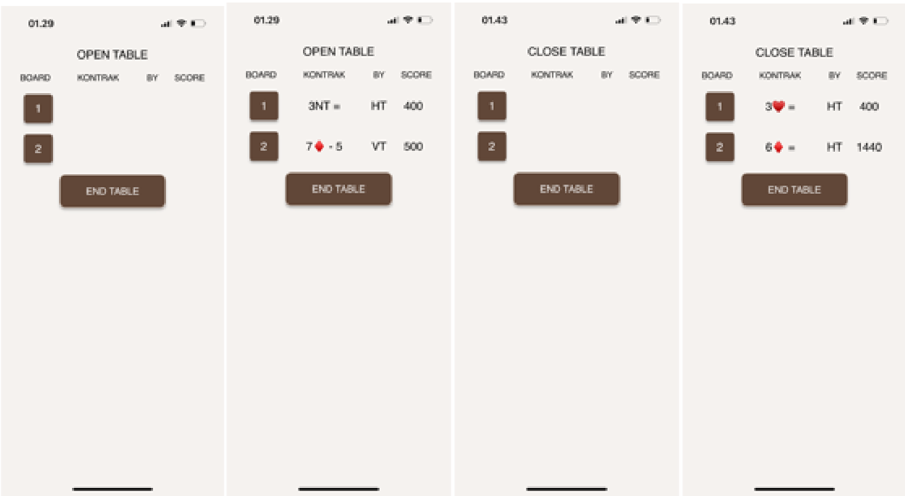

Figure 8. Score submission page

Figure 9. Scoring pages: users enter contract results, calculate scores per board

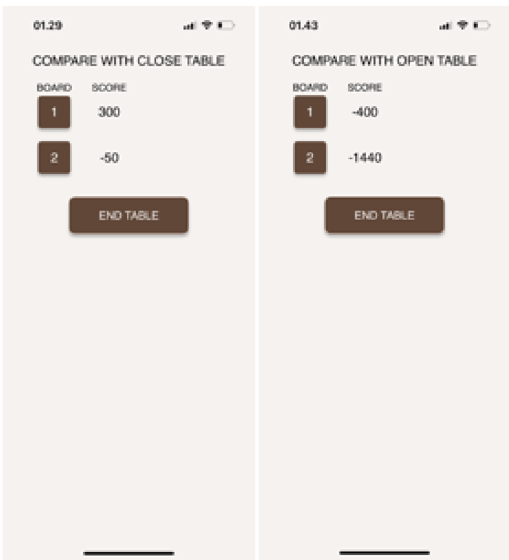

Figure 10. Comparison page: transferring results from closed table to open table

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Figure 11. Result page: display final game result

b) Testing and Evaluating the Solution: Testing was conducted with bridge players familiar with the game's scoring system. The evaluation involved two university bridge clubs, Universitas Negeri Malang and Universitas Brawijaya, as well as a regional bridge community in Kabupaten Sidoarjo. The testing compared the accuracy of score calculations between the application and traditional score sheets (manual method). Testing was performed directly using the actual application on iOS devices, ensuring real-world evaluation of its functionality. Participants interacted with the app in live game scenarios, inputting scores as they would in an official competition. In each location, eight bridge athletes participated, and total test was conducted five times. The results showed that when using the application, no scoring errors were detected. In contrast, the manual method consistently produced errors in every test session. The error rate in manual calculations ranged from 8% to 36% per test session, primarily due to miscalculations of IMP scores and incorrect data entry. This finding highlights the app's reliability and potential to improve scoring accuracy in bridge competitions. Additionally, feedback from testers indicated that while the application effectively streamlines scoring, its availability is currently limited to iOS. To increase accessibility and adoption, future development should consider expanding support for Android devices.

c) Implementation and Evaluation: The final implementation involved introducing the app to bridge clubs at Universitas Negeri Malang, Universitas Brawijaya, and the regional bridge community in Kabupaten Sidoarjo. Players used the app in live match scenarios, inputting scores as they would in an official competition. The goal was to ensure that the app seamlessly integrates into competitive bridge scoring systems while maintaining accuracy and usability. Evaluation is an ongoing process, with user feedback driving further refinements. Future iterations will focus on expanding accessibility by developing an Android version to increase adoption.

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5 Conclusion

This study successfully developed the Bridge Team Comparator application as an automated scoring solution for bridge tournaments on iOS. The application enhances accessibility, accuracy, and efficiency in scoring compared to manual methods and electronic devices like Bridgemate, which have cost and availability limitations. By providing a free alternative to expensive electronic scoring systems, Bridge Team Comparator ensures that bridge players and tournament organizers, regardless of budget constraints, can benefit from real-time, automated scoring without incurring significant expenses. By utilizing the Challenge-Based Learning (CBL) approach, the development process followed the Engage, Investigate, and Act phases to ensure a user-centered solution. The CBL framework allowed iterative development based on real-world user feedback, ensuring the application met practical needs and usability requirements. This method also emphasized hands-on learning and problem-solving, aligning with modern software development practices that prioritize user experience. Testing results demonstrated that the application effectively reduces scoring errors compared to manual methods while also accelerating the calculation of International Match Points (IMP). Trials conducted with bridge athletes from various universities and bridge communities in Indonesia confirmed the app's accuracy, with no scoring errors detected, highlighting its potential for competitive use. The key innovation of this development lies in integrating automated scoring with mobile technology, reducing reliance on costly dedicated devices like Bridgemate. Additionally, the app introduces a structured digital solution tailored to bridge tournaments, improving the traditional manual scoring approach. For future development, expanding to an Android version is recommended to increase accessibility and adoption within the bridge community. With this innovation, the Bridge Team Comparator contributes to the digitalization of traditional sports scoring systems, particularly in bridge tournaments, while also opening opportunities for further research and development in sports scoring automation.

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