Gorga : Jurnal Seni Rupa
Vol 14, No 1, (2025) 345-353
ISSN 2301-5942 (print) | 2580-2380 (online)
https://dx.doi.org/10.24114/gr.v14i1.64668

Available online : https://jurnal.unimed.ac.id/2012/index.php/gorga

Design of a Footflash Application as a Footwork Detector for Badminton Players

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***How to cite*:** Christine, J. (2025). Design of a Footflash Application as a Footwork Detector for Badminton Players. *Gorga : Jurnal Seni Rupa*, *14* (1), 345-353. https://dx.doi.org/ 10.24114/gr.v14i1.64668

Article History : *Received: March 24, 2025. Revised: April 21, 2025. Accepted: June 30, 2025*

ABSTRACT
As a national sport in Indonesia, badminton requires agile footwork to achieve success in competitions. However, players often struggle to maintain consistent techniques and receive real-time feedback. A qualitative approach using the design thinking method was applied, including interviews, usability testing, and prototype observation. In the define stage, How Might We questions were formulated to guide the solution. The ideate and prototype stages resulted in key features such as motion detection and progress tracking. In the test stage, four active badminton players evaluated the usability and effectiveness of the application. The usability test results showed that color-coded motion tracking on the Apple Watch helped users understand their mistakes. Feedback from users prompted design iterations on performance analysis features, video tutorials, and training intensity adjustments. This study demonstrates that directly listening to users' opinions and experiences is essential in designing sports technology that is effective and easy to use. Future development will focus on incorporating artificial intelligence (AI) to tailor training based on user abilities and progress, as well as gamification elements to enhance user engagement.

KEYWORDS

Badminton Training, User-Centered, Footwork Detection, Design Thinking, Footflash

INTRODUCTION

For the people of Indonesia, badminton is a source of national pride, supported by the availability of facilities and infrastructure in nearly every region (Zakir et al., 2022). Badminton can also be classified as a high-speed sport, where the shuttlecock can be hit at speeds exceeding 250 km/h (Malwanage et al., 2022). Therefore, it is crucial for badminton players to be able to control their agility to succeed in matches. This can be achieved through proper footwork training. On the court, footwork performance is marked by the ability to control acceleration or deceleration and direction changes, in order to improve shot accuracy and overall performance (Rathod et al., 2023). Some players with faster footwork also demonstrate increased acceleration, further emphasizing that good footwork plays a key role in achieving optimal results (Chiu et al., 2020).

While traditional methods to improve footwork, such as personal coaching or training sessions, often come with high costs, technology offers new ways to develop footwork skills. This has led to the creation of mobile applications that can assist badminton players directly. However, most current sports software focuses more on tracking health data, with around 74% dedicated specifically to monitoring cardiac and pulmonary functions, emphasizing respiratory and heart rate monitoring (Bez & Simini, 2018). On the other hand, applications specifically designed for badminton footwork training are still limited. There are several apps such as "Badminton-Footwork" and "Badminton Footwork Trainer," but their features remain limited, especially in providing real-time feedback and in-depth analysis of the user's footwork technique. Therefore, an application called FootFlash was developed—an iOS app with motion capture capabilities designed to provide real-time feedback on

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users' footwork. Using the lean canvas approach (Maurya, 2022), FootFlash was developed based on market needs to be more effective in helping badminton players improve their footwork technique.

Table 1. Lean Canvas

PRODUCT			MARKET	
Problem • Badminton players struggle to improve their footwork on their own. • Lack of real-time feedback and accurate training tools to improve footwork. • Inconvenience of hiring personal coaches or attending formal classes.	**Solutions** • Advanced motion detection technology to evaluate footwork accuracy. • Seamless integration with Apple Watch for real-time performance feedback. • Statistics, video playback, and progress tracking for skill improvement.	**Unique Value Prop.** Real-time motion feedback to help badminton players improve their footwork independently and efficiently.	**Unfair Advantage** • Real-time motion-based feedback using advanced motion detection technology. • Niche focus on footwork for badminton players, a unique and underserved market.	**Customer Segments** • Amateur and professional badminton players (Generation Z and Millennials, ages 20–40). • Fitness enthusiasts interested in badminton. • Coaches who want to give their players better tools.
	Key Metric • Number of active users • Retention rate. • Premium subscription revenue. • Positive usability testing feedback.		**Channels** • App Store for download. • Digital marketing through social media. • Partnerships with badminton clubs and fitness influencers.	
Cost Structure • App development and maintenance. • Marketing and partnerships. • Cloud storage for user data.			**Revenue Streams** • Freemium model: Basic features free, premium features by subscription. • In-app purchases for advanced tutorials and content. • Sponsorships and partnerships with sports brands.	

The lean canvas model shows that FootFlash plays an important role by identifying clear problems, offering technology-based solutions, and outlining a viable business model to meet the needs of players looking to enhance their footwork.

This application emphasizes User-Centered Design (UCD), a method that focuses on understanding user experiences and needs to identify and solve problems, resulting in solutions that are effective and tailored to user requirements (Arifin et al., 2024). UCD aims to create products that are practical, convenient, functional, and enjoyable by observing user behavior, desires, and challenges. Hasanah & Grahita (2024) state that in *The Design of Everyday Things*, user experience is defined as the overall experience and feelings of users when interacting with a product. As a complementary aspect, usability refers to the efficiency, effectiveness, and satisfaction experienced by users when completing tasks related to a product (Borsci et al., 2018). By emphasizing UCD, UX, and usability simultaneously, the main goal of product development is to create something that is not only usable but also enjoyable for users (Liikkanen, 2016).

FootFlash exemplifies this recommended approach. The main function of the app translates video into users' foot movements in real-time with the help of the Apple Watch, which continuously analyzes video over a given period. Users must wear the Apple Watch, place the iPhone on a tripod sequentially, and perform footwork drills. During training, the watch will display green for correct movements and red for incorrect ones. After each training session, user feedback and video recordings are documented on the app's statistics page. In addition to this functionality, FootFlash also allows users to create personal profiles, track achievements, and prepare for each stage in their skill improvement process. These diverse features make the app a highly useful tool for badminton players, from beginners to professionals, to independently enhance their abilities.

METHOD

This study applied design thinking using a qualitative approach, which involved collecting information through interviews, usability testing, and user observation with the prototype. There are five interrelated stages in design thinking: empathize, define, ideate, prototype, and test (Farosa & Irfansyah, 2023). Each stage in the app development process is interconnected, and the use of design thinking enables continuous improvement and refinement. The design thinking process can be explained through the following stages:

1) Empathize
   In this initial phase, observation is conducted to gather the desires, needs, and behaviors of potential users. Through in-depth interviews, this process aims to understand user needs and problems, as well as how a product can help address them.

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2) Define
The information collected during the empathize stage is synthesized to identify and formulate the core problems experienced by users. This step is used to gain a comprehensive understanding of user needs and to build a foundation for an appropriate solution.
3) Ideate
This phase involves generating a wide range of ideas to solve the problems that have been defined. Various ideas are evaluated to find the most ideal and feasible solution that aligns with user expectations.
4) Prototype
The prototype phase is the final stage in the design process where the UI/UX designs developed during the ideation phase are implemented. With a prototype, the proposed solution can be better understood and tested in detail before actual development begins.
5) Test
Usability testing is used to evaluate the effectiveness of the FootFlash application, including user interaction with all aspects of the app. Users are specifically selected, and their use of the app is closely observed. These testing sessions assist in making decisions regarding design improvements, app operations, and which features to include

RESULT AND DISCUSSION

1. Empathize

Interviews with five prospective users representing various skill levels (beginner, intermediate, and advanced) were conducted to gather relevant information about their daily activities, preferences, and challenges during badminton training:

1) The need for personalized feedback on footwork techniques: All respondents highlighted the importance of receiving specific feedback on their footwork techniques. This aligns with research indicating that feedback is essential in the training process, as it allows players to evaluate their movements based on expected outcomes (Rusmiati, 2019).
2) Time constraints and the need for flexible training: Many users faced challenges in scheduling regular training sessions, leading them to seek more flexible training options. A flexible training system allows them to select sessions that match their conditions while still achieving significant performance improvement within eight weeks (Walts et al., 2021).
3) Desire for comprehensive analysis and progress tracking: Intermediate and advanced players emphasized the importance of in-depth analysis and the ability to monitor their progress over time. Studies show that understanding various aspects of athletes' well-being—including physical, emotional, and psychological—helps in designing more effective training strategies and supporting overall health (Shah et al., 2024).
4) Social aspects as a source of motivation in playing badminton: Social interactions, such as competing with friends, were identified as a major motivational factor for many players. Research confirms that competitive elements significantly enhance intrinsic motivation and player participation (Toh & Choon Lian, 2024).
5) Interest in technology-based training with considerations for effectiveness: Most respondents expressed interest in training solutions that leverage technology, although they also raised concerns about its effectiveness. Studies indicate that the success of adopting technology in sports training depends on resolving technical challenges and maintaining a balance between technological tools and the role of human coaches (Ghezelseflou & Choori, 2023).

2. Define

As a next step, How Might We (HMW) questions were formulated to guide more specific solutions to these challenges. When faced with complex problems that have various possible solutions, asking different questions can help uncover new innovations (McKilligan & Creeger, 2018). The following HMW questions were developed:

1) Motivation: How might we encourage and sustain players' desire to continue practicing badminton footwork in a positive way? Interview results indicated that social aspects, such as

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training with friends or receiving new challenges, were primary motivational factors for many players.
2) Preferences: How might we tailor the learning process to individual needs in terms of training and appropriate feedback? Some players expressed the need for more personal and specific feedback to better understand their footwork mistakes.
3) Accessibility: How might we ensure that the proposed solution is easy to use for players of various skill levels, including those with little experience using apps? Most respondents showed interest in technology-based solutions, but they were concerned about ease of use and effectiveness during training.
4) Time management: How might we assist badminton players in managing their training time despite having busy schedules? Many users reported difficulty in setting aside time for regular training, making flexibility in scheduling a primary need.
5) Use of technology: How might we ensure that the technology used in this solution is effective in improving players 'footwork skills? Respondents emphasized that the technology should offer an efficient training experience without disrupting their focus during play.

In addition, the user persona in Figure 1 was developed to illustrate user characteristics and gain deeper insights into the challenges they face. With this approach, the solution can be tailored to meet the needs of badminton players across various skill levels.

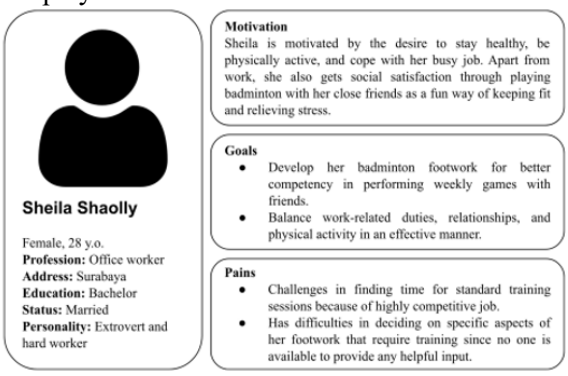

Figure 1. User Persona

3. Ideate

At this stage, solutions were developed based on the problems and needs previously identified using the *How Might We* questions. The four-quadrant model shown in Table 2 was used to select and develop the most promising ideas that align with user needs while considering time constraints.

Table 2. Four-Quadrant Model

How Might We	Possible and Promising	Delightful but Difficult	Impossible but Groundbreaking
Motivation: How might we encourage and sustain players' desire to continue practicing badminton footwork in a positive way?	Enhancing the gamification experience by adding badges and achievements. Providing individual performance reports.	A feature that allows users to compete directly with friends or other users.	Utilizing VR/AR to create a realistic badminton game with AI players, while accurately evaluating the user's footwork in real time.
Preferences: How might we tailor the learning process to individual needs in terms of training and appropriate feedback?	Providing various types of feedback (text, audio).	Delivering customized feedback by modifying training intensity, which varies according to the user's fatigue level and performance	AI technology that analyzes movements in real-time and adjusts training based on the player, their physical condition, and environment.

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Accessibility: How might we ensure that the proposed solution is easy to use for players of various skill levels, including those with little experience using apps?	An extremely simple onboarding begins with a combination of text and visuals.	The "Beginner Mode" simplifies the application interface and explains the process through sequential steps.	Integration of voice and gesture commands enables completely hands-free interaction with the application.
Time management: How might we assist badminton players in managing their training time despite having busy schedules?	Short training sessions lasting 5 to 10 minutes with high intensity.	An AI assistant that analyzes the user's schedule and recommends the most suitable training sessions for their busy days.	The use of biometrics to determine training efficiency based on the user's health condition and energy levels, and to adjust the training plan in real time.
Use of technology: How might we ensure that the technology used in this solution is effective in improving players' footwork skills?	The use of AI-based video analysis to provide instant feedback on players' footwork techniques.	A gamification system with scores and AI-driven challenges tailored to the player's skill level.	The use of Virtual Reality (VR) or Augmented Reality (AR) to simulate live match scenarios and provide interactive real-time training.

Based on Table 2, the application should not only focus on addressing the core problems but also include key features such as motion detection, instant feedback, detailed statistics, training tips and tricks, and profile customization.

At this stage, the visual elements—such as logo, color palette, and typography—were also designed and determined. Figures 2 to 4 illustrate the visual elements that will be presented in the application interface:

a. Application logo

The FootFlash logo, especially the logomark, is inspired by the footwork movements of a badminton player. The design also reflects the application's name, "Foot."

Figure 2. FootFlash Application Logotype

b. Typography

Figure 3. Typography Used in the FootFlash Application Interface

c. Color

FootFlash uses red for its logo and primary components, as shown in Figure 5. According to Ferrão (2022), red symbolizes strength and energy and captures attention. This aligns with FootFlash's goal of being a footwork training companion and evoking that sense of energy in users. FootFlash uses white and black as secondary colors. The white background helps users understand the content and highlights important information, while black text improves readability and visual comfort.

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Figure 4. Colors Used in the FootFlash Application Interface

d. Alur pengguna

Before designing the user interface, the user flow in Figure 6 was developed to map the sequence of actions within the application, making it easier to use.

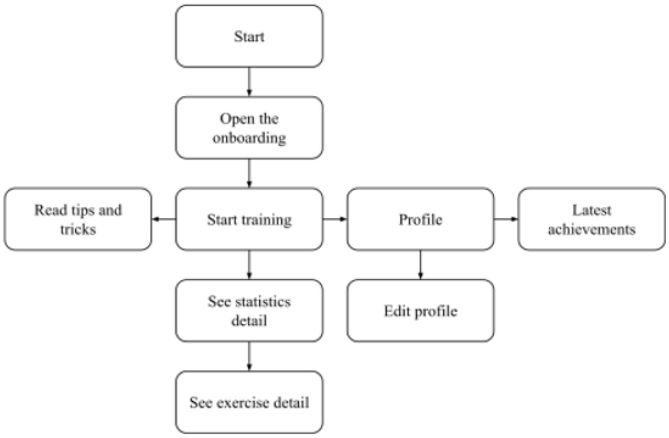

Figure 5. User Flow

4. Prototype

At this stage, a high-fidelity prototype was created using Figma to ensure that the application elements function properly and can be tested for usability. Figure 6 presents the final interface design of the FootFlash application.

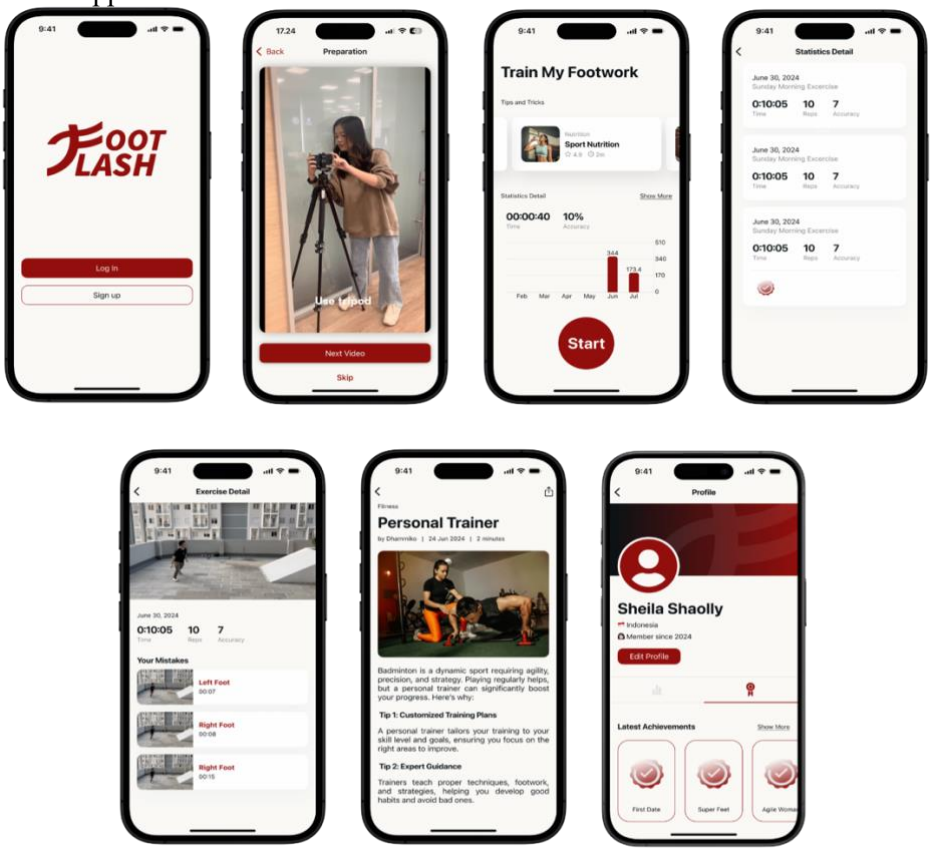

Figure 6. Interface Design

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The features are described as follows:

1) Onboarding
   This feature helps users become familiar with the application and its functionalities through three slide pages containing videos and narration. The focus is to explain in the simplest way how the camera should be held and used in conjunction with the Apple Watch. After completing these pages, users can proceed by clicking the *Train My Footwork* button at the bottom of the screen.
2) Train My Footwork
   This feature encourages users to begin a training session and receive real-time feedback. During the session, correct and incorrect movements are indicated in green and red, respectively, on the Apple Watch. After the session, users are directed to the next page to preview their video and track their progress.
3) Statistics Detail
   This page allows users to view their training history, including the date and time of each recorded session. Special achievement badges will also appear at the top of the screen when earned. By tapping on any session record, users are redirected to the *Exercise Detail* page, which is tailored for each training history entry.
4) Exercise Detail
   Users can watch their training videos through this page to observe performance changes over time. This page also highlights specific moments when users made mistakes.
5) Tips and Tricks
   Accessible from the *Train My Footwork* page, this section contains short articles that explain the fundamentals of improving footwork and endurance.
6) Profile
   This feature allows users to update their personal information and view their latest achievements, accessible directly from the *Train My Footwork* page.

5. **Test**

Four active badminton players—including a design facilitator from Apple Developer Academy, an intern, and three players from a local badminton court—were recruited to conduct qualitative testing of the FootFlash application. This testing aimed to evaluate the application's ease of use, effectiveness, and user interaction with the interface. After completing tasks in the FootFlash app, post-test interviews were conducted to gather qualitative insights. The main questions focused on:

1) Emotional responses to the interface and workflow of the application
2) Obstacles or confusion encountered during navigation and feature usage
3) Suggestions for improvement

Participants appreciated the app's ease of use and the real-time footwork tracking feature. However, they expressed a desire for more detailed performance analysis and video tutorials within the *Tips and Tricks* section to help improve their techniques. These findings were used to implement changes in the UI/UX, focusing on enhancing the usefulness of feedback in the next app update

CONCLUSION

Through the implementation of the five stages of design thinking, this study successfully identified several key findings. The *empathize* stage revealed that the primary needs of badminton players centered around real-time feedback, flexible scheduling, and social motivation. In the *define* stage, the formulation of appropriate *How Might We* questions effectively guided the solution toward a more focused direction. The *ideate* and *prototype* stages resulted in a technical solution involving the integration of Apple Watch with intuitive color visualizations, while usability testing in the *test* stage demonstrated the effectiveness of this approach and revealed the need for more in-depth analysis. This study highlights the value of the iterative process in developing technological solutions for sports.

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